ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. VII.

REVISION OF THE ECHINI.

BY

ALEXANDER AGASSIZ.

IN FOUR PARTS.

WITH NINETY-FOUR PLATES AND SIXTY-NINE WOOD-CUTS.

UNIVERSITY PRESS, CAMBRIDGE,
WELCH, BIGELOW, & CO.
1872–1874.

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NOTICE.

THE concluding Parts (III. and IV.), containing the description of the species not included in Part II., and a review of the anatomy and classification of the order, will be issued as soon as practicable.

ALEXANDER AGASSIZ.

PART I.

INTRODUCTION.

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INTRODUCTION.

THE present Revision of the Echini has been in my hands for the greater part of six years; its publication has been delayed from the impossibility of examining a large number of the original specimens of the principal writers on the subject. Its earlier appearance would have been useless without such an examination. This was made during a recent visit to Europe, when the species of Echini (with very few exceptions) described during this century were examined, and carefully compared with specimens sent from the Cambridge Museum to Europe for that purpose.

Of many of the specimens we have, of course, only the tradition that they are the originals made use of by various authors; this is especially the case with the types of the older authors in the Jardin des Plantes and in the British Museum; but as no one has recently attempted to make direct comparisons of the numerous species described independently, it is not astonishing that when such a comparison is made the number of species distinguished should be found to be so small.

To Dr. John E. Gray and the late Dr. Baird of the British Museum I am indebted for giving me every possible facility to examine the collections of the British Museum, containing the types of Dr. Gray's Catalogue of Recent Echini, of his papers in the Proceedings of the Zoölogical Society of London, in the Annals and Magazine of Natural History, in the Annals of Philosophy; to Dr. P. L. Sclater for his kind assistance in hunting up the types formerly in the collection of the Zoölogical Society; and to Dr. Charles Stewart for his aid while working in the rooms of the British Museum.

The collection of Echini made by Professor Percival E. Wright at the Seychelles Islands was examined at Dublin. Dr. Carpenter and Mr. Jeffreys allowed me to examine, in company with their colleague, Professor Wyville Thomson, the Echinoderms, collected in the different cruises of the English Deep-Sea Dredging Expeditions, which had been brought together

at Belfast. To the Rev. A. M. Norman I am indebted for information respecting several British species. At Liverpool, in company with the curator of the Derby Museum, Thomas J. Moore, the excellent collection of Echinoderms brought together by his care was examined; it contains numerous interesting species from localities rarely represented in collections.

At Stockholm, in company with Professor Lovén, the booty of the Josephine Expedition was carefully examined, and I had also the opportunity of seeing authentic specimens of most of the species described by Scandinavian authors, most admirably preserved, as are all the Invertebrate Collections of the Stockholm Academy,—a model, indeed, to be followed in the system adopted for exhibition. To Professor Lilljeborg I am also indebted for information respecting some of the Echini of Linné, still preserved in the Museum of Upsala.

At Copenhagen Professor Steenstrup allowed me the freest access to the collections of the University; and in company with Dr. Lütken I had the opportunity of examining specimens of the species described by him in his Bidrag, and of improving my acquaintance with the species of the Norwegian coasts.

To Dr. G. O. Sars I am indebted for a complete series of the species of Echini inhabiting the coast of Norway, collected at the Lofoten Islands during his Dredging Expeditions.

Professor W. Peters and Dr. Martens, of Berlin, most kindly gave me access to the originals of the Echini described by the former from Mozambique, and by the latter from the eastern seas, principally from Japan.

At Hamburg, Mr. C. L. Salmin and Dr. Schmeltz, the curator of the Godeffroy Museum, gave me the freest access to the materials which interested me, while to Dr. Shilling, curator of the Hamburg Museum, I am indebted for similar favors.

Through Professor Grube, of Breslau, I have had access to the remarkable Echini he described in 1867, and which have thus far remained unique in the history of Echinoderms.

In Leipzig, a few interesting species from Australia were shown me by Professor Leuckhart. Professor Kölliker gave me the freest access possible to the collections in his charge, while Dr. Semper allowed me to make a very careful examination of his magnificent collection of Echino-

derms from the Philippine Islands, from which most valuable information respecting the geographical distribution of many species was obtained.

At Frankfort, I examined the collections made by Rüppell in the Red Sea.

At Stuttgart, Dr. Krauss allowed me the freest use of the collection of Echini made by him at Natal.

In the University Museum at Bonn I found the types of Philippi, as well as those of Professor Troschel himself, to whom I owe this opportunity of examining them.

To Professor Ehlers I owe the discovery of the original specimens of Klein, the most valuable historical collection of Echini in existence, which has served as the basis of all the names proposed by Leske; and as they are generally adopted, it has been of incalculable service in clearing up a multitude of doubtful points. Through his exertions the Senate of the University of Erlangen allowed the collection to pass to America for examination.

At Neufchatel, M. Louis Coulon placed at my disposal many authentic specimens which formed a part of the material of the Catalogue Raisonné. A few other species were found at Geneva through the kindness of the late Professor Pictet. M. de Loriol spent considerable time in examining with me his valuable collection of recent and fossil Echini, among which were some interesting species from Ceylon collected by Mr. A. Humbert.

The basis, however, for the accurate determination of most of the species of Echini was found in the collection of the Jardin des Plantes. There are preserved the originals of most of the species of Lamarck, and all the collections brought home by the great French Exploring Expeditions. This collection formed the chief part of the material of Blainville, and again of the Catalogue Raisonné, so that without a very critical examination of this collection no commencement could be made.

Professor Deshayes allowed me to examine the collection of the Jardin des Plantes as if it were my own, and all possible assistance was rendered me in identifying the types by Messrs. Rousseau and Potteau, whose long acquaintance with the collection made it possible to identify many things of which the tradition must soon be lost.

Professor Lartet gave me the opportunity of examining the few recent species described by D'Orbigny still preserved with the rest of his collections in the Paleontological Department of the Jardin des Plantes.

To Mr. Cotteau the Cambridge Museum is indebted for a fine series of the many new genera and species described by him in the Échinides de la Sarthe, in the Paléontologie française and other papers. In his private collection at Auxerre were also authentic specimens of many of the species described by Desor and Michelin; the recent species it contains have been in many cases labelled by both Michelin and Desor.

Another most important collection, containing much of the material of the Catalogue Raisonné, is the collection of Deshayes and that of Michelin, now in the École des Mines. Michelin described a large number of species, which are here carefully labelled in his own handwriting, making it possible to identify all the species described by him in the Revue et Magazin de Zoologie, thanks to the courtesy of Professor Bayle.

At Vienna, I saw the collections of the Novarra Expedition made by Frauenfeld.

The only collection of importance which I have not personally examined is that of Desmoulins, owing to the breaking out of the Prusso-French war. The greater part, however, of his species are in the collections of the Cambridge Museum, having once formed a part of the collection brought to this country by Professor Agassiz, with whom he was in correspondence during the working up of the Catalogue Raisonné.

To Mr. Bouvier I am indebted for a most interesting collection from Cape de Verde Islands. To Mr. Crosse for a number of species from New Caledonia, and to all the gentlemen named above for typical specimens carefully compared with the originals of all the species which could be spared. I have thus succeeded in bringing together in Cambridge, with the addition of the information obtained by comparisons with specimens sent from Cambridge for that purpose, an unrivalled historical collection, for which I cannot thank too cordially the many friends in Europe who have so generously assisted me in my labors.

The materials existing in the United States have in a similar way been carefully examined. The whole of the collection of Echini of the Smithsonian Institution has, thanks to the generosity of Professors Henry and Baird, been in my hands for a considerable period. It contains the materials of the several explorations of the east and west coast of the United States, made under the direction of the Smithsonian. To Dr. Stimpson I owe the opportunity of studying the Echini of the North Pacific Exploring Expedition, collected by himself. The Academy

of Natural Sciences of Philadelphia allowed me, through Professor Leidy, access to their collection containing many interesting species, especially from the South Pacific. Professor Verrill has invariably communicated to me with the greatest readiness the species he was describing from the Museum of Yale College. To Mr. Putnam I owe many valuable specimens from the collections of the Essex Institute, principally from Zanzibar and other portions of Africa.

The collection of the Museum of Comparative Zoölogy itself contains the types of the majority of the species of the Catalogue Raisonné; the immense collections of Echinoderms made by Mr. A. Garrett at various points in the Pacific Ocean, by Mr. C. Cook at Zanzibar, by Mr. Henry Edwards in New Zealand and Australia, by Mr. Thomas G. Cary at San Francisco; the collections of the eastern coast of the United States from Maine to Florida, made by Professor Agassiz; the collections of the Thayer Expedition in the West Indies and Brazil; a collection of Mediterranean species made by Professor Panceri; the collections of Mr. Pourtalès from the deep waters between Florida and Cuba; my own collections from Panama, the west coast of Mexico, California, and the Gulf of Georgia, besides innumerable exchanges made with other museums which will be noticed in their proper places.

The material accumulated in Cambridge represents, with but four or five exceptions, every species described during the last forty years. A good deal of unpublished matter collected by Professor Agassiz for the continuation of his Monographies d'Échinodermes has been incorporated in this Revision. The freest use has also been made of preparations made under his direction by the late Nathaniel Bowditch, and of a collection of sections of spines of Echini begun by Mr. Glen and continued by Mr. Bicknell with admirable success. Mr. Bicknell has also made for the Museum microscopic preparations of such pedicellariæ and spicules as have been found necessary.

For the careful execution of the lithographic plates I am indebted to Mr. P. Roetter; to Mr. A. Sonrel for the preparation of the negatives needed for the Woodburytype and Albertype processes which have been employed for some of the Plates of this Revision. I have also to thank Messrs. E. Bierstadt, of New York, and John Carbutt, of Philadelphia, for the trouble they have taken in making the necessary adaptations of their methods of printing to the needs of Natural History illustrations.

I must beg indulgence for the mistakes of omission and commission which have undoubtedly found their way into the first part containing the Synonymy. I shall be greatly obliged to be notified of any errors discovered hereafter by those who may make use of this Revision.

ALEXANDER AGASSIZ.

CAMBRIDGE, August, 1872.

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In addition to papers containing descriptions of Genera and Species, everything relating to the recent Echini, to which I have had access, has been brought together which had any bearing on the anatomy or classification of the order. Papers and memoirs on fossil Echini which were considered essential to a proper understanding of the affinities of the recent species have also been added. Papers containing merely descriptions of new species of fossil Echini have been omitted, but wherever generic divisions are discussed or proposed they have been quoted. The full titles have not been quoted (but they are abbreviated so as to be readily recognized), as the Catalogue of Scientific Papers by the Royal Society, and the usual Bibliographical works and Reports now regularly published, will furnish the desired information. Carus, in his Bibliotheca Zoologica, is very severe upon the Bibliographia Zoologiae of Agassiz, edited by Strickland. I do not wish to enter into a criticism of his views, but would remark that he has himself been quite as guilty of sins of omission, as far as the present order is concerned, as the author of the Bibliography he so sweepingly condemns.

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* Dr. Kersten has seen fit, in the Preface to Decken's Reise, to make an extremely violent and impudent attack on the Director of the Museum of Comp. Zoölogy for not having laid at his feet the collections of the Museum, made at Zanzibar. The Director of the Museum has invariably, whenever possible, and for the interest of the Museum, sent the materials at his disposal to well-known naturalists, not only in this country, but also abroad, as the following partial lists of collections intrusted to European scientific men will fully show: — Prof. Allman, Barrande, Prof. Geinitz, Dr. Kölliker, Prof. Keferstein, Prof. O. Schmidt, Dr. Ehlers, Prof. Selenka, Dr. Smitt, Dr. Gerstaecker. As Dr. Kersten had no claim whatever to have valuable collections intrusted to his care, his demand (it was not even a request) was treated as it deserved. — A. AGASSIZ.

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NOMENCLATURE.

So much has already been written on the subject of Zoölogical nomenclature that the only excuse I have for adding anything on the subject is to give the reasons which have prompted me to adopt a somewhat unusual course in treating this question, and to state explicitly on what grounds I have adopted views differing radically from those of so many naturalists.

We seem apparently all agreed in considering synonymy our *bête noire*, yet any attempt to introduce reform has invariably raised a general outcry, and matters have been left to run their course unchanged. The question naturally arises, if we can go on indefinitely as we are doing. Are we not bringing Zoölogy into disrepute, lessening its scientific character, in allowing a mere shuffling of names to pass as science and place itself as an immovable barrier to all better work? Most of us have at some time or other worked up some monograph in which the questions of nomenclature have absorbed more time — and with no satisfactory result — than the remaining scientific portions of the paper. Is it not possible to adopt some nomenclature which will make it clear to all what we mean without involving this great loss of time? In all matters of nomenclature there are two main points to be brought out conspicuously: in the first place, the original name of the species we are discussing; and in the second place, its present position in the Zoölogical System. The notation to be adopted for these two points would seem to be simple enough, and so it would be were we to speak of a species always by its original name; but when we attempt, by the notation commonly received, to give a succinct history not only of the species, but also of the name of the species, it is not remarkable we have failed to define clearly so much with such a defective nomenclature. Availability in practice must, after all, modify any principles, which may work very well as far as one class is concerned. If the principles are conducive to present stability and direct research again into its proper channel, the object is gained; for to obtain ultimate stability of nomenclature is as hope-

less a task as to fix the limits of a species; to accomplish that, we must ask science to come to a stand-still; but if we are willing to reduce nomenclature to its proper functions, we need not waste, as we do now, our time upon bibliography.

The attempt to trace the origin of the generic names now in use among Echinologists is far from giving satisfactory results. There are writers of three distinct periods who have increased the confusion already existing at their time.

The first is the period of Linnæus and Gmelin. They took no account whatever of what there was good among their predecessors, ignoring as far as Echinoderms were concerned much valuable work by Klein, Leske, Breynius, which compares very favorably with many papers on the same subject, even of the present day. They were followed by Lamarck, who ignored as completely as his illustrious predecessor the work previous to Linnæus.

In the second period we have the attempts of Gray, Blainville, Agassiz, Desmoulins, Desor, to take into account, as far as possible, what had been omitted by their predecessors, and to give due credit to Breynius, Klein, Leske, Van Phelsum, for whatever there was original in their memoirs. Breynius, as early as 1732, had, to some extent, adopted a binomial nomenclature, accurately (for his period) discriminated genera and species, many of which are readily recognized, but which had escaped the notice they deserved till a comparatively recent period.

In the third period, subsequent to the publication of the Rules of the British Association for the Revision of Nomenclature, we have the writers from 1845 up to the present time, Agassiz, Desor, D'Orbigny, Cotteau, Wright, Forbes, A. Agassiz, Lütken, Verrill, and others, who have attempted more or less successfully to apply these rules, and have in many cases only increased the existing confusion. By going back to the earliest writers, and restoring as far as practicable the condition of things then existing, we can see how far we must modify the nomenclature generally adopted by the Echinologists of the present day, and yet give due credit to the pioneers of this department of Zoölogy. In the discussion of this question I shall not be guided by any cast-iron rules of priority, nor do I acknowledge the right of the British Association, or of any other association of scientific men, to dictate how and in what way certain fixed axioms (fixed only by them, and subsequently remodelled) shall be my guide in the matter of nomenclature. The authority of great scientific names has just as little to do in this question, and I must

frankly state that I do not intend to impose the names I propose upon any one. I shall simply attempt to reconcile the past with the present, and show, as far as can be ascertained, what species the old authors probably intended to describe. As far as the question of priority of the specific name goes, the only guide I shall take is an original or authentic specimen, and when a species which has once received a definite name can be recognized, the oldest name shall be preserved to the exclusion of all others, if the change is based upon authentic specimens, and not simply upon a figure, a guess, which may or may not be a true one. It is, however, not in the matter of the specific name that uncertainties and doubts and differences of opinion are likely to arise, but in the binomial combinations, particularly with reference to the generic name and the limitations we choose to assign to it.

Scarcely an original investigator recognizes within the same limits all the genera adopted or proposed by his predecessors. New discoveries must constantly modify our points of view, and in accordance with this state of things I look upon binomial combinations as expressing (as a matter of record) the opinion of any investigator of the affinities and of the history of the species mentioned by him in his monograph. I also here wish distinctly to protest against the habit which has become so prevalent among systematic Zoölogists, to make the rules of the British Association retrospective. We have no right to go back previous to 1840, and say to Lamarck, "When you limited the genus **Spatangus**, you should have included in it only such species as **Spatangus pectoralis**; or go back, in 1825, to Gray, and because he names as belonging to **Echinocardium**, **E. lacunosus**, to change all the species which have, since Lamarck, been separated from **Spatangus** as *Plagionotus*, back to **Spatangus**, change next all species of **Spatangus**, making a new name for it and for *Plagionotus*, change **Schizaster** into **Echinocardium**, suppress **Echinocardium**, devise a new name hence for *Moera*,* for **Amphidetus**, — in fact, I will undertake, by following out strictly the rules of priority, and other rules as established by the British Association, for the sake of obtaining greater accuracy, and to simplify nomenclature, to change the generic and specific names of seven eighths of the received names of recent Echini, — a process which would be highly conducive to accuracy, and which I respectfully decline to go through, leaving this pleasant task to others who may feel disposed to undertake it. To save them trouble they will find all the necessary material in the accompanying pages of Synonymy.

* Preoccupied, LEACH, 1813, and HÜBNER, 1816.

Can we carry out successfully any laws of nomenclature? Must we not always be guided, when treating special cases, by the practice current at any given time? Have we the right to introduce distinctions unknown at the time of Linnæus, of Klein, of Leske, for the sake of harmonizing the past with the existing condition of our knowledge? When Leske says his *Cidaris esculenta* is the *Echinus esculentus* of LIN., we can only say that, from what we know now, after examination of authentic specimens, they are different species, even belonging to different genera; such a comparison forms a substantial basis for the correctness of our recent specific names. When we come to apply the same rule to genera, the case is not so simple. Is it advisable to restore **Echinanthus** KLEIN, as Gray has done, to the exclusion of **Clypeaster** of LAMK., when the exact limits of the genus as understood by Breynius and by Lamarck show that although they included many identical species, yet they were by no means equivalent? We cannot afford to lose from the history of the order the early names, but we had better lose them if we are to introduce them at the cost of making endless confusion by giving them definite meanings their originators did not intend them to have. We can, without injustice to subsequent workers, frequently keep both names; but I claim that where a name is not used in the same sense in which the originator intended it, it should not be preserved and substituted to exclude subsequent names representing distinctions and differences of which the original writer could not have been aware.

Echinoconus BREYN., **Echinanthus**, **Echinospatagus**, **Echinobrissus**, need not be used to the total exclusion of Lamarck's names or of more than one of the genera into which **Echinoconus**, etc. has been subdivided subsequently; yet if afterwards any writer limits **Echinoconus**, etc., such limitation can always be understood or stated, and the old name retained for a section at least of the many genera each is composed of. I claim that writers who mentioned as type of a genus certain species did not ăttach to it the significance we now do; they used it as an *illustration* of what they meant by taking a well-known thing, and the very fact that they frequently made the type of their former genus the type of another, leaving to the first only other species either originally included or subsequently added, sufficiently shows what was the current opinion of the nature of a genus at that particular period. The fact is, that our species stand very much in the relation of a variable of which we are constantly (or were up to a comparatively recent date) attempting to state the value by means of constants.

Lamarck, in 1801, established **Nucleolites** and **Cassidulus**. In 1816 he transposed the species included in these genera, and we find in one case but one, in the other not one, of the original species left in the genus; this we can interpret in two ways: either Lamarck learned something between 1801 and 1816, extended, with the material at his command, the definition of the genera, and found that in 1801 he had included in **Cassidulus** species which really should have been separated from it; or else we must say, Lamarck's interpretation of the genus **Cassidulus** in 1816 was incorrect, the only correct definition is that of 1801. I prefer to take Lamarck's view to my own or that of any other naturalist who, fifty years or more afterwards, comes upon the stage and tells us what Lamarck meant or should have meant. Here it is that our confusion begins. It is by our attempts to interpret with our present knowledge a condition of things which we can with very best intentions but faintly reconstruct, that we are frequently doing gross injustice to previous workers. I will take another example, that of **Echinocardium** Gray; he established this genus in 1825, placed in it what is now known as **Moera atropos** and **Echinocardium cordatum.** Because he afterwards (1835) restricted the genus **Echinocardium** to the second species (**E. cordatus**), and Agassiz subsequently placed in **Schizaster** this same (**S. atropos**), together with **S. canaliferus**, must we for that reason go back to the original meaning of Gray, restore **Echinocardium** for **Moera**, cancel all the species of **Echinocardium** by giving them a new generic name,—as Agassiz's **Amphidetus** cannot be retained, being synonyme of **Echinocardium**, as modified by Gray, not of the original **Echinocardium**,—next make a new name for **Schizaster**, for that is synonyme of the typical **Echinocardium**, and therefore must be dropped? This is perhaps an extreme case, but a similar mode of procedure has been adopted in other somewhat less complicated cases, the proposed recent changes being based upon old rectifications or emendations of the authors themselves which late writers have not allowed. I frankly acknowledge I do not see the strength of the argument which presumes to correct Lamarck fifty years after he wrote, and correct him, not because he was wrong, but because he ought not to have done something which the practice of certain Zoölogists of the present day disapproves. It may be highly creditable to a writer's acumen and critical knowledge of the existing condition of nomenclature to set up this man of straw and bravely knock him down, but it is not Zoölogy, and the sooner this style of writing, based entirely upon books, and not upon specimens, is done away with the better.

Our genera are constantly modified, and all we can do to define them is to state the limits within which we understand a genus; hence the difficulty of applying the rules of priority to generic names where the limits are so uncertain. The daily increasing list of specific and generic synonymes but too plainly tells the tale of our ignorance. Are we to attempt to define with mathematical accuracy what we mean by a species because we find it convenient to use a binomial nomenclature to express zoölogical units? As well attempt to solve an equation of an infinite number of unknown quantities by means of an equation of the second degree. In our nomenclature the best we can do at the present time is, by the examination of original specimens, to ascertain what are the limits at any time of what we mean by a certain binomial combination, and to express these limits by our synonymes. The fact is, that we can no longer define species as has been customary, and, with all descriptions, their value to other observers depends generally upon the amount of material at the command of the describer and of the reader. How can we enable others to ascertain what we mean? Scanty materials from few localities seem to limit a species within narrow limits, and no difficulties appear. But take an example of one of the most widely distributed species, — **Hippon. variegata**, found in Japan, the Sandwich Islands, Indian Ocean, east coast of Africa, the Red Sea, — and the diagnosis of the species will be very different if based upon material limited to any one locality, or perhaps upon African, or Japanese, or Sandwich Islands specimens only, and we find them appear as **Hipponoë subcoerulea** or **pentagona**, or **Hipponoë violacea** and **nigricans.**

A large number of systematic Zoölogists claim the necessity of recognizing geographical varieties by means of binomial names or of some kind of notation. What greater claim have they to be recognized than other categories, which are all members of the same species? The part these geographical species play in the limitation of Marine Faunæ is important, and the limits of our geographical subdivisions are closely linked with our interpretation of species; we cannot lose sight of the question of geographical variation any more than we can lose sight of the question of growth of an individual. But because geographical differences have received certain specific names before their connection was traced through intermediate gradation from many localities, must we for that reason retain this historical fact, any more than we are justified in retaining as a specific name the name of an animal which has afterwards been shown to be the young stage of one

previously described, or any more than we are justified in retaining the name of Pluteus paradoxus for the young, Ophiura for the adult, the name of Coryne for the Hydroid, and of Sarsia for the Medusa, or of Brachiolaria for the embyro Star-fish, and Asteracanthion for the adult. The synonomy and history of the species must show us all this, and any student of Invertebrates will readily call up countless instances where, if the principle of geographical names is once introduced, we might have half a dozen names which have a stronger claim for recognition to denote the different conditions, the various stages of growth of Echinoderms, Polyps, Acalephae, Crustacea, Annelids, Insects, Mollusca, and even Fishes where the genetic connection is not readily traced; yet no one has ever thought it feasible, or even advisable, to retain these connecting links, but, on the contrary, all writers have attempted, as far as in their power, to show why they reduce the number of appellations. We may call the various stages of growth by different names, as the Pupa Chrysalis or Imago, the Zoëa, the Pluteus, the Nereis, Heteronereis stage, the Amphioxus stage, — but we stop there; they are simply convenient terms to denote our finite knowledge; and in no way do we lessen their value by saying that we have no accurate definition of species, or by saying that species belong to the same categories as genera, differing only in degree; and so in admitting all the most zealous evolutionist could require, it does not lessen the fact of the finite condition of the differences we now notice, and which we call species or genera or families or orders, as we class them in various categories. For their transition, if such a transition does exist, can only take place through an infinite series, which still leaves the problem capable of a definite solution within fixed limits at any special time; and this is all that is needed for our purpose.

We know nature only through individuals, and whatever conclusions we draw are based upon the examination of a number of individuals showing a certain range of variation within definite limits, and these limits we call in some cases specific, in others generic, in others ordinal; and as long as we confine ourselves to the interpretation of nature, susceptible from such finite data, we need not trouble ourselves as to the metaphysical existence of species, genera, etc., or because we have no suitable definition of species applying to all classes of the animal kingdom, which, in the present state of biological science, it is absurd to expect. We are agreed for the present to call certain categories specific, others generic, others ordinal, and it matters only to us that we should distinctly state the

limits we assign to these categories in some way readily understood; and this the individuals or groups of individuals themselves belonging to the different categories will supply. Taking a small group like the Echini, in which the number of species is not large, we can readily follow in all the species the value of the characters which have been called ordinal, generic, or specific, and cannot fail to see how inadequate our diagnostic descriptions become as soon as we attempt to incorporate with them even the scanty information of the present day of the life history of any one species.

The genera recognized are usually based upon some structural features derived from the pedicellariæ, the poriferous zone, the character of the tubercles or their arrangement, the abactinal or actinal system, and general facies. Their value, when tested by our present knowledge of the changes they undergo, seems limited almost to convenient headings or keys for the more ready identification of species. Genera, as we recognize them among Echini, are certainly not founded upon features of general and permanent value, but, on the contrary, upon features applying only to a few species, and of very limited application. During the growth of the Sea-urchins of different groups, certain parts (different for the various divisions) change rapidly, others do not, and it is to these permanent characters, limited in their application, that we must resort as guides for our generic tests.

The structure of the pedicellariæ is very variable; in the same species they may be present in abundance, or totally wanting in specimens living under the same conditions. Yet, as characteristic of some groups, they furnish, as far as we know, excellent points of distinction. In some genera the number of the rows of vertical tubercles is constantly increasing; in others, the number of the tubercles alone increases. The perforation and crenulation of the tubercles, as far as we can judge from recent species, furnish excellent characters for a class of subdivisions; but what shall we call them? The poriferous zones give us good features to distinguish such groups in the adults as **Toxopneustes**, **Toxocidaris**, **Loxechinus**, **Sphaerechinus**, yet these same characters would not help us to place the young of the above in their proper genera; though, knowing the limits of the changes to which the poriferous zones are subject, they are an invaluable auxiliary in classification, in spite of their uniformity among all the Cidaridae.

The general facies which might, with accuracy, tell us that we deal with a young **Echinometra**, would certainly mislead us when we have before us the young of many a Spatangoid or Clypeastroid. The notches of the actinal

system, considered of such primary importance, are constantly likely to mislead us, by placing young and old in different genera. The changes in the abactinal system are as varied, yet, when we have once ascertained what is the range of variation for a group, the characters it affords are of the utmost value. In the irregular Echini, where the changes during growth are very marked, we find genera and species based upon characters the value of which is not the least understood. The shape, the position of the anus, the structure of the ambulacra, have always been considered essential; yet embryology teaches us that nothing varies more during growth than the outline, that the anus may be placed almost anywhere during the growth of the individual, and that the ambulacra may at one time be identical with those of the regular Echini, and pass through all intermediate changes to the petaloid state. We find, among Spatangoids, in the position of the apex, that of the mouth, and in the presence of the fascioles, features of primary importance; with Clypeastroids the structure of the interior proves thus far our safest guide; while among the Echinolamps we come upon a group beset with difficulties, where everything seems variable, and the changes passed through from young to adult would warrant placing the different stages of growth in each of the principal subdivisions established among Echini.

All our characters are variable; the greater our range of comparison, the less our standards become fixed or stable. How can we denote all this? Are we prepared to use a notation which will express these changes and be intelligible? Can we do more than give a rough sketch of such a condition of things? Our notation must be the growth of our knowledge, and its meaning and application must be simple; in spite of the definite existence of what we call species, genera, etc., when we apply these terms to limited regions and series of the present day, yet we find them totally inadequate to express our wider interpretation when our standards of comparison are infinite in time or space.

It is found impossible in practice to determine when a species is sufficiently described or not; hence no attempt can be made to discriminate in favor of this or that name on account of the character of the description. What was ample to separate the few species of Clypeaster known at the time of Lamarck becomes useless when describing species of the genus in 1870. From insufficiently described species (or so considered) we pass imperceptibly to mere catalogue names, known only from specimens deposited in public museums, or by the distribution of casts, or of types; finding

all possible gradations from these mere catalogue names to short diagnoses, short descriptions, or often a longer one, but not a whit more useful. What is an ample description to a thorough student or a specialist will fail most certainly to become adequate to the tyro or the master even of a different department. Where shall we draw the limit? Shall we take it for granted that our readers have the same material we have at their disposal, which we know not to be the case, or shall we presume that the student who is to consult the work has absolutely nothing except what any given locality on the coast is likely to furnish him? What appears a most simple question to be decided by a snap-judgment from small collections assumes a totally different aspect when the materials have been drawn from all possible quarters of the world; and in a monograph like the present one, to attach the same importance and to give an equal amount of space to each species would be impossible, while a full description of the most characteristic species of each genus (accompanied by figures) seemed the most appropriate method of dealing with the subject, the descriptions of other allied species becoming more or less comparative.

At first sight the question of giving to each species its true name (that is, the name it first received) seems a perfectly plain one, the choosing of the older being only a question of our ability to trace this; so it would be were we dealing with zoölogical equivalents. But what we now call our units (our species) are not the units of the time of Linnæus, or of the beginning of this century, any more than our present units are likely to be those of the last part of this century. Thus, at the very threshold of the question, we introduce an arbitrary element in our appreciation (from our present stand-point) of the condition of things at a different period. The names of these collective species, as they have been called, certainly ought not to disappear from the history of our science, if we can retain them by making such a limitation of these old units as we find it possible to make with our present units. Hence, when such a limitation has once been made for good and sufficient reasons by a previous writer, no one ought, except for better reasons, to attempt to make a revision of the limitation of these old names, unless the material at his command, such as an examination of the originals of the old author or carefully preserved tradition, evidently warrants him in upsetting generally received combinations. In the interpretation of such authors as Rumph, Breynius, Leske, Linné, when access to their collections is no longer possible (as their collections are irretrievably lost), we

can only be guided by collections made from the same localities, and adopt what seems most probable as correct, retaining, whenever possible, the names of the old authors, either for the species, as we now understand it, or for some part of the old collective name limited in a way which appears to have the greatest probability in its favor.

The strictest adherence to the rule of priority* must be our only safety as far as the specific name is concerned; for once admit only a moderate application of this rule, subject to the regulations of any scientific body or person, and we introduce endless confusion. Each case is to be judged by itself on its own merits. An old name, and the oldest name, once re-established, there is an end to all disputes; but as long as we except this for one cause, and that for another, we open the door for endless discussions between those who wish the exception to be made in one way rather than in the opposite, while perhaps they would both agree on the older name. In adopting an old name, the question of its appropriateness frequently seems a valid reason for preferring a more recent name, and one apparently more suitable. The old name was given to the young, or it was an abnormal condition, while the recent name applies to the usual form; yet why should

* It is, indeed, puzzling to ascertain with justice when an antique name should be substituted for a more recent one; by recent I mean any name posterior to Linnæus. There are, of course, as a general rule, all the arguments in favor of the adoption of the time of Linnæus, of some special edition of the Systema Naturæ, as the starting point for the adoption of strictly binomial names. Unfortunately, in the case of Echinoderms we can hardly say that Linnæus did even justice to the works of his predecessors. To unite as Asterias and Echinus all the subdivisions proposed by Link, by Breynius, was certainly a step backward at that time. Link, Klein, and Breynius specially showed a philosophical treatment of their subject far in advance of their age, and it was not till after the first quarter of this century that their labors began to be properly appreciated. This long neglect is certainly no excuse for not adopting what there is good in their works; and because Linnæus refused it recognition, we should not, if we can, fail to give them, the pioneers in the study of Echinoderms, due credit for what belongs to them. This difficulty of establishing the first starting-point for the adoption of the binomial system is not limited to Echinoderms alone. It occurs in other classes of the animal kingdom. It seems to me that whenever we can, with the aid of authentic specimens, restore the names proposed by these earlier writers, where, as is frequently the case, they propose excellent generic divisions, we should not hesitate to adopt them, no matter how great a disturbance it may bring into recent nomenclature. But I wish to be distinctly understood to admit that this is only practicable from an examination of authentic specimens, and that I have no wish to perpetuate names based upon descriptions or figures of old authors, or upon any lucky guess proposed concerning them. The above remarks apply not only to generic names, but also to specific. We frequently find in old authors, either accidentally or not, binomial names; these have been restored when an examination of authentic specimens made it possible. Of course, when no such *nomen triviale* of Linné (our specific name) was to be found, no attempt has been made to re-establish from the *nomen specificum* (the diagnoses of our days) a specific name, by selecting a suitable combination.

that be a reason for its adoption? What is normal here is not normal somewhere else; the young are frequently found in one place, while the old haunt totally different districts; in one place the old name would be perfectly proper; the other would be, for equally good reasons, adopted in another locality. The same objection may be made to geographical names when they are the oldest, and yet are found to apply to species of most extraordinary geographical distribution. It seems, at first glance, very unfortunate that the specific names of **Dröbachiensis** and of **sardica** * should have to be retained for species having such an extensive range, — in one case, from the Sandwich Islands, Japan, Indian Ocean, to the Red Sea; and in the other, on the two sides of North America, throughout the Northern Atlantic to Norway and Siberia and the coast of Kamtchatka. There certainly is nothing in a name if we judge it by its appropriateness, especially in the case of **H. sardica**, which is not found in Sardinia at all; yet what do we gain by substituting any of the synonymes, such as **neglectus** or **saxatilis** for **Dröbachiensis**, as has been frequently proposed? The time of geographical names is as much a part of the history of our science as any other, and if it has passed out of date, let us recognize it in the future by avoiding such names, but do not let us attempt to obliterate the past of our history by too much wisdom in our present time. Some writers have gone so far as to recognize the validity of geographical names for the sake of showing how far a species was cosmopolitan and the variations to which it was subject, retaining these names even after all the possible gradations existing between the two extremes had been clearly traced. If we allow this principle, where shall we stop?

The propriety, or rather the feasibility, of retaining the same generic name in different departments of Natural History has frequently been discussed. Botanists all agreeing to retain a generic name, even when employed in Zoölogy, we need only return the compliment and examine the possibility of retaining the same generic name in different branches of Zoölogy. It is claimed, on the one hand, with great plausibility, that, owing to the constant and more definite specialization of the different branches of Zoölogy, there can be no clashing of any consequence. Some Entomologists even go so far as to retain the same generic name for the various sections of entomology when it may be, apparently, employed safely. They see no objection to a Lepidopterologist, Coleopterologist, an Hymenopterologist, or a Dipterologist duplicating generic names. We strike here

* *Hipponoë variegata* A. AGASS. from authentic spec. of KLEIN.

upon an arbitrary distinction, — what constitutes an independent department now is not likely to remain one always; specialists may hereafter play a very unimportant part in the general progress of Natural History, and it seems as if we were knowingly introducing a most fertile element of discord into the discussion of the stability of generic names, — a question already sufficiently complicated. Are we to follow this same rule for Echinoderms and the other Radiates, where the number of species of each order is comparatively small? Can we repeat a generic name in Annelids, in Crustacea, and in Insects, because they belong to different classes? The intimate connection existing between Echinoderms and some Annelids seems likely to make a department of these two classes; and those who study Annelids or Crustacea are certainly of necessity compelled to have something to do with other Articulates. In fact, the Marine Invertebrata, Radiates, Mollusks, Articulates, will always remain a special field of study; and their connection with other classes of the same branches is so intimate that we cannot, consistently, draw a line for the retention of generic names, which would be limited by special departments of study.

When writing the Nomenclator Zoölogicus, Professor Agassiz proposed a large number of alterations in the spelling of the generic names in accordance with their correct etymology. It certainly would be a most desirable end to have our generic names etymologically and orthographically correct, but we are prevented from making the improvement, however desirable, from our inability to deal with names which have no etymology, and which we must either throw out or accept as they stand; if we accept them, we cannot refuse the same privilege to names partially or nearly correct; so that, when quoting an author, it is always best to quote him verbatim and retain his spelling. The only correction allowable seems to be that of the gender of the specific name attached, which should be corrected in our own books, but quoted in the synonymy as it stands. For this reason the same genus in the accompanying Chronological List, when spelled differently, is always supposed to be a new genus; of course in the synonymic list this is not the case, unless it is clearly a typographical error, in which case the fact is mentioned in brackets. If it were advisable, therefore, to retain **Cidaris** and **Cidarites**, I claim that they are *not* identical, the termination being amply sufficient to distinguish them; and we ought not to reject names differing as little as **Moulinia**, **Moulinsia**, **Moulinsium**, **Cassidula**, **Cassidulus**, simply because they are likely to be mistaken for one another; in our pres-

ent condition, with an infinite number of genera, a difference, no matter how slight, should be sufficient reason for retaining the name instead of coining a new one, which is just as likely to fall into the same category, and resemble another name in a different department to as great an extent. It will compel a little more accuracy in the very class of writers who are so punctilious and so anxious that nothing should be named twice, but who are constantly, in spite of this, making two equal three.

The completeness or insufficiency of the diagnosis of a genus is a worthless reason for rejecting a generic name; we find all possible gradations between a mere catalogue generic name and an admirably defined section. The impracticability of defining what a genus is, — for what two naturalists, working in the same department, admit the same limits? — shows the impossibility of applying to genera, as strictly as to species, the rules of priority. In old generic divisions which the advance of science has subdivided, it is of course advisable to retain the old names for some one section; but for which section? Here the most opposite views are current, one party claiming that you can limit the old name to any group of species of the original genus, the other that you must apply to these old generic names the same rules which have been proposed by the British Association, very likely long after the genus was established. The first have, at any rate, in their favor, the practice of the authors themselves, whom we find afterwards in their later works limiting their genera to any group of species originally contained in it. Old names are frequently thrown out on the occasion of such subdivisions, for not being grammatical, or for not being spelled correctly. Should we throw out **Brissus**, as universally spelled by Latin authors, because they should have spelled it **Bryssus**, then we must throw out a more modern genus **Leiocidaris** because it should be written **Liocidaris**, or **Echinopatagus** because we should say **Echinospatangus**, or **Nina** and **Metalia** for which our lexicons furnish us no clew. Let us remember that probably the greater part of our Zoölogical genera is made up with the assistance of a Greek Dictionary, and its correspondent parts joined to the best of our knowledge and belief; we can scarcely expect to obtain in this way classical names which the old Greeks would be willing to father. When, therefore, we take so much pains in presenting to our readers the derivation of the generic names, we should rather call it the composition. The meaning of words with the ancients has changed with the course of time, exactly as we find it in our own language;

but no one has for that reason compelled us to go back to the original meaning of the word, and, furthermore, no one expects it. Our only choice seems to be to quote an author as we find him, and give him all the benefit of his spelling, both for the generic and specific name as well as the gender of the latter. If we find, as is so frequent, **Diadema, Echinodiscus** .... with feminine species, **Diadema longispina**, etc., or **Salmacis** * **sulcatus, Echinodiscus aurita**, etc., we may correct the gender, but our office must end there.

It seems to be equally available to consider a proper name (Peron) as Latinicized into *ius* (Peronius), making the specific name Peronii, or to *us* when the case requires it; or else to consider the name as indeclinable, and add *i* to it for the specific name. Changes made, as is frequently done from one mode of viewing the subject rather than the other, seem inappropriate for reasons made sufficiently apparent previously.

To incorporate new material into recognized genera simply from descriptions, or even with the help of figures, is almost always an impossibility. The time has come when such work, at least in monographs, should be discountenanced, and no recognition paid to the numerous nominal changes, a mere shuffling of cards, so frequent in our Zoölogical literature. Let them receive the distinction they deserve as more or less successful guesses, and let due recognition be given to work based upon an examination of the originals or of authentic specimens. If the practice of showing by (*) or (!) what we know from personal examination were more uniformly adopted, much time would be saved in discussing subjects about which neither party has any accurate data. This plan has been followed throughout this monograph, and the (!) — *Echinus* **tuberculatus**! LAM. — means that I have seen the specimens themselves, or what are considered as such. When there is reason to doubt the authenticity of the specimen, the question-mark denotes it (! ?) — *Cidaris* **annellata**! ? GRAY. The same notation is also used after the locality, — Sandwich Islands!

It was indeed "a true Pandora's box let loose upon science" when the practice of adding the authority after a name was adopted. Not that we can expect even specialists to remember who are the authorities for any particular combination, but this notation, to be worth anything, must mean something, and particularly refer us to some place where information on the subject can be obtained. When I write *Echinus* **ovum** LAM., I mean that in some work of Lamarck's he has mentioned a species (he may have de-

* A *Nymph.*

scribed it first there or not) by that name and refer to him for further information. If I write *Amblypneustes ovum* Agass., I intend to say that Agassiz has somewhere mentioned a species by that name, and reference to the proper work will show if he means a new species or an old species. If I write *Amblypneustes ovum* Lam. *sp.*, I may or may not remember where the genus *Amblypneustes* was first published, — and in the multiplicity of genera at the present day to remember where a genus was first proposed is as impossible as to remember always where a species was first described, — the reference simply tells that after Lamarck's time somebody removed *ovum* to the genus *Amblypneustes*, but we get no other information to be made available without further search. The practice of regarding the authority given after a quotation simply as a *matter of reference*, and not as conferring any special honor or distinction on the writer quoted, would go far, I am persuaded, to do away with such constant changes, made with the only idea, I presume, of gratifying somebody's vanity, for the change of name teaches us nothing.

The practice of the old writers before the time of Linnæus was to cite authors, and, not being burdened with the question of authority, they were quoted for the information to be found there. The mode in which our synonymy is made up will, if analyzed, show us that this is the clearest way, perhaps, out of the various difficulties. We do not, in making our synonymes, write simply *Amblypneustes ovum* Lam. *sp.*, and omit everything else; we write

Echinus **ovum** Lam., 1816, A. s. V.
Amblypneustes ovum Ag., 1841, Anat. g. Ech.

we refer to the place where information can be obtained, and when speaking of a species we have therefore two ways open, — either to adopt the method of always quoting it as first named, which is its true name, *Echinus* **ovum** Lam.; or else to use a reference, — the last reference is not always the necessary one, but that reference which we think truly expresses our ideas of its relationship. For this reason I would say *Amblypneustes ovum* Agass. If anybody either previously or afterwards has transferred the species to a genus which does not agree with my views of its affinities, I do not quote it when speaking of it, while another author may do that in accordance with his views. Whichever name we adopt, the quotation of the appropriate place where further information can be found is given, which is not supplied by writing *Amblypneustes ovum* Lam. *sp.* The

synonymy will always give us the proper place of reference of the special combination adopted, while placing the first name under this, in place of all quotations, will show exactly what we mean. We have therefore adopted the principle of separating from the text all questions of bibliography and of history, which seem to find their natural place together, but which certainly are not to be considered Natural History, much as they may serve to clear our ideas and prevent confusion. By writing, therefore,

Amblypneustes ovum
Echinus **ovum** LAM., 1816, A. s. V.
Amblypneustes ovum AGASS., 1841, Int. Anat. g. Ech.,

I refer the reader at once to the place where the species was first described, and to the place in the synonymy where he will find the necessary historical information relating to the adoption of the name **Amblypneustes ovum**. If I have occasion to speak of this species, I shall most certainly speak of it as *Amblypneustes ovum* AGASS., as a mere matter of registration of Agassiz's opinion, which would be accompanied by no special glory to Agassiz, but be stating my agreement with his views of the affinities of *Echinus* **ovum** LAM.

All attempts to discriminate between the baptiser and the describer have proved futile. The gradations between what we can call a good description or a bad one, and a mere name recognizable from its connection, make it useless to draw any invidious distinctions in favor of the describer.

In works written by two authors, they are both quoted as the authority, unless in the body of the work itself a particular author is specified for certain species or genera. It is but justice to recognize catalogue names, or other information, sent to authors writing on a particular subject and published by them as manuscript names; it is furnishing finished material which would naturally fall under the head of joint authorship as soon as published, and due credit should be given to the author of this work, and not to the author of the volume alone. Free scientific relations must cease if the imparting information, freely given when asked, is, on account of its irregular mode of dependent publication, to be ascribed to the recipient of such information.

When names are changed in the transfer of a species from one genus to another, to avoid having two species of the same name in one genus, great care must be taken afterwards, if either of these species undergo a further change, to restore the original names, when confusion is no longer possible. The original name is frequently lost sight of in these generic transfers, and great care must be taken never to obliterate it.

In the case above mentioned, by adopting for the name to be changed one of its available synonymes, any transfer of the species afterwards which would make a return to the original name possible becomes a matter of course. In fact, we should always as much as possible transfer ourselves back to a special epoch and reconstruct the existing conditions, not only of the nomenclature, but also of the special department we are investigating. Great injustice is too frequently done to memoirs admirable for their time by judging them harshly in the light of recent information, frequently gained by the aid of the very memoirs so ungenerously treated, which have helped to clear the ground. It is easy to ameliorate. The man of genius lays the foundations, while the elaborate superstructure raised by his followers long after his time hides from their view the fact that he has made their part possible.

In giving the synonymy of species which have become historical, which have a wide geographical range, and are to be found in monographs, books of travel, lists, hand-books, it becomes a necessity to cull the long list of quotations misnamed Synonymes, and to separate what is merely bibliographical from what constitutes the history of the name and the history of the species. In the history of the species we need all the possible combinations which have been recorded as expressing its affinities, but for the history of the name we must frequently go back to earlier dates and consult books where we find no information of any value. If the practice were adopted generally of giving only such quotations as enable us to gain some kind of information, a better description, notes of the geographical distribution, anatomical or physiological points of interest, we should, little by little, get rid of an evil which is daily becoming more intolerable. We can hardly expect our successors to continue to drag this dead weight, and the sooner we get the benefits of a similar course the better. There are two principal points of interest, the starting-point, or the original name, and the present interpretation, or the name we adopt. The one is the variable quantity, the other its value, in our estimation, for the special case under consideration. Is it necessary that we should always go through all the details of the solution of the problem? Let us adopt something, at least, from mathematics, and when we have solved such simple problems on our slate, let us rub out the figures and leave the answer; or if we must show how we have solved it, let us publish the figures on our slates separately, for the benefit of those who cannot, or will not, follow us; but let us draw a line at least, and a distinct one, between the bibliographical part, the name of the species, the history of the

species, and the natural history of the species. The last plays but an insignificant part too often, while the history and bibliography encroach upon the natural history, and to an alarming degree are believed to be substitutes for it. Zoölogical monographs must hereafter depend, to a great extent, upon the examination of authentic specimens, and no one has any claim to ask his peers to spend their time in testing the accuracy of his guesses. When he has examined large materials or original collections, his opinions are to be considered and criticised on other than personal grounds, "*sine ira et studio.*" All appeals to unprejudiced people on questions of nomenclature and personal criticisms, in discussing guesses on questions based most frequently upon myths, do not increase our knowledge one iota; and if careful study of materials at my command has compelled me to differ from the views generally adopted by most writers on Echinoderms, I am expressing an opinion based upon extensive materials, and I trust no one of the many friends to whom I owe the information I have been able to collect will receive my work in any but the most impersonal manner.

An attempt to carry out these views has been made in this memoir. I shall consider myself fortunate if I can succeed in persuading others to simplify their work by getting rid, to a great extent at least, of the *bête noire* of Zoölogists, and apply their time to better things. We can do this without sacrificing accuracy, or losing our hold upon the past, which is certainly an important point, but should not be maintained at the cost of preventing all future progress.

Systematic Zoölogy, viewed, as it should be, as the connecting link between the different departments constituting Biology, has a totally different meaning from mere nomenclature. It becomes an epitome of years of study, the concise expression of the thoughts of a writer on the affinities of the animals he is discussing. Systematic Zoölogists have, until lately, laid claim to be exclusively recognized as Zoölogists; they should remember, now at least, that Physiology, Comparative Anatomy, Morphology, Embryology, Palæontology, Histology, Psychology, and Geographical Distribution are as much a part of Zoölogy as the mere questions of classification and of nomenclature. Great as have been the benefits derived by following the precepts of Linnæus, we must nowadays return to old Aristotle and take him for our guide. The Aristotelian view of the whole knowledge of the life of an animal is the true conception of what Zoölogy should be; the convergence towards this broad base of Zoölogy, by workers in the different fields

mentioned above, shows the necessity of some element in common to express the variable quantities constantly obtained in various departments from a closer and more accurate examination of nature. This element systematic Zoölogy furnishes; it gives us the quantities to make our equations, and when it takes this broad form is no longer a mere dry collection of meaningless names, but becomes our interpretation of nature. The facility with which, in a new country, unknown animals can be described, the notoriety thus readily obtained, is a strong incentive to descriptive work; not that I would, as is frequently done, deny all value to systematic Zoölogy, but it should not be forgotten that the true purpose of useful systematic work must be to increase our knowledge of the relationship of animals to special groups already known, or serve in some way as a connecting link in the chain of the various branches of Zoölogy. We have our independent memoirs of systematic Zoölogy, of Psychology, of Palæontology, of Comparative Anatomy, of Histology, etc., treating of their respective sciences as isolated departments all strongly biassed by the characteristics of the sciences from which they originated. Comparative Anatomy and Physiology, as well as Histology, are the children of Human Anatomy, and this, in its turn, was gradually developed from the needs of Medicine. Embryology and Palæontology, though so intimately connected, are rarely treated together, the latter being considered to belong, by birthright, to Geology. Psychology is but now becoming emancipated from speculative Philosophy. We have no recent Zoölogical memoir in the Aristotelian sense; the sciences forming the branches of Aristotelian Zoölogy stand upon separate pedestals. They have grown up independently of one another, yet they all converge towards a common point, each an important part in the life history of every animal; and the common link which is to unite them all is (when rightly understood) systematic Zoölogy.

Working in this spirit, systematic Zoölogy helps us in our attempts to understand the laws of nature; these must remain unintelligible to him who is busy with naming and classifying materials, reducing his science to an art, merely accumulating facts to be stored in museums, forming as it were a library of nature. To him its books will be inaccessible, and its laws as inexplicable as are the laws of the motions of the planets to one who has no knowledge of the existence of gravitation.

EXPLANATION OF THE CHRONOLOGICAL LIST.

EVERYTHING relating to the *history of the name* is to be found in a CHRONOLOGICAL LIST of all the species of Echini having binomial names and all the possible combinations under which these species occur at different periods. When a name *first* appears, no matter if a new genus, or species, or a synonyme, it is printed in a special type (**Cidaris**). When the same name appears subsequently, it is printed in a different type (*Cidaris*). Each author, each paper, book, or memoir is kept separate, and receives a special heading with the quotation of the book, which holds good for all species arranged strictly chronologically. Thus in

1734.

KLEIN, Nat. Disp. Echinod. ......

Cidaris	Appears for the first time.
toreumatica !	appears for the first time.

1758.

LINNÉ. ......

Echinus	Appears previously.
rosaceus.	appears for the first time.

1776.

O. F. MÜLL. ......

Echinus	Old name.
Dröbachiensis ! ?	New name.

1778.

LESKE, Additamenta ad KLEIN.

Cidaris	Appears before.
papillata	New species.

1780.

Under FABRICIUS. ......

Echinus Appears previously.

saxatilis !? non RUMPH, nec LIN. nec MÜLL. = *Echinus* **Dröbachiensis** MÜLL. 1776

a combination which appears before, but represents a different species identical with a species previously described by MÜLLER in 1776.

1837.

DESMOULINS. ......

Echinolampas Appears previously.

Richardi (**Desml.**) non DESMT. = *Echinolampas* **Hellei**, VAL. 1869

shows that the *Richardi* of Desmoulins is a new species which has subsequently received the name of **Hellei** in PERRIER, Pédicellaires.

Genera are treated in the same way, but, owing to their variable limits, no attempt has been made to show which are the synonymes, and a generic name when it first appears is always printed in the heavy type, as **Scutella**, 1816, LAMARCK ......

When a generic section is proposed, which may or may not be valid, but of which the name is preoccupied, it is denoted in the following way: —

1869.

A. AGASSIZ, Bull. M. C. Z.

Lissonotus (**A. Ag.**) non SCHÖN. 1817.

If it is strictly a synonyme within the same limits of a well-defined older genus, it is denoted as follows: —

1862.

DUJ. HUPÉ, Échin. .....

Polyaster non GRAY, 1840.

the synonymy of the species giving all the necessary information.

To show that a species known previously appears again in a new genus, the following notation is adopted, if referred to a new genus: —

Clypeaster which appears for the first time under LAMARCK in 1801.

rosaceus ! as an old species in a new genus. Figures afterwards in GRAY, 1825, as

Echinanthus

rosaceus ! meaning that Gray transferred *rosaceus* to a genus already established previous to his time, while a new species of GRAY, of the genus *Echinanthus*, already established, is denoted thus: —

Echinanthus

testudinarius !

the (!) notation showing at once which types I have personally examined.

The only synonymy introduced in the Chronological List is the adding of the original specific name to a synonyme when it first appears. Thus, in LAMARCK, 1816, we find,

Echinus

neglectus! = *Echinus* **Dröbachiensis** MÜLL. 1776.

Showing that Lamarck described as a new species what had already been described as *Echinus* **Dröbachiensis** by MÜLLER, or that I consider it to be the same species, which may or may not be a correct view.

Typographical errors figure as new names, and are denoted as follows: under FORBES, 1844, we find,

Amphidotus (err. typ.) **Amphidetus** AGASS. 1841. The correction is at once indicated.

The light and heavy type are used throughout the book to denote the relations the specific and generic names bear to the authority of the special case, but it does not necessarily follow that because we write *Encope* **micropora**, under AGASSIZ in 1841, Mon. Scut., that the genus **Encope** was not established by him; it merely denotes that he described as belonging to *Encope* the species **micropora**, at a different period or in a subsequent paper to the one when **Encope** was first established. See 1840, AGASSIZ, Cat. Syst. Ectyp., **Encope grandis**, where the genus was first named.

In the Chronological List fossil genera have been introduced in their proper order.

CHRONOLOGICAL LIST.

ARISTOTLE, Hist. Anim., Lib. 4.

Ἐχῖνος.
Βρύσσος.
Σπάταγγος.
Ἐχινομήτρα.

1554.

RONDELET, Libri de piscibus marinis, ... 1554, p. 578.

Echinus
ovarius = *Echinus* **granularis** LAM. 1816.
Echinus Spatagus et Brissus = **Spatagus purpureus** MULL. 1776.
Echinometra ...... = *Echinus* **melo** LAM. 1816.

1606.

ALDROVANDI, De reliquis animalibus, ... 1606.

Echinus
spatagus.
Echinometra maxima pelagica sardica = *Echinus* **melo** LAM. 1816.

1705.

G. E. RUMPH. D'Amboinske Rariteit Kammer, 1705.

Echinus
esculentus = *Cidaris* **variegata** LESKE, 1778.
saxatilis.
niger.
Echinometra
digitata prima.
" *secunda.*
setosa.
Echinus
sulcatus = *Echinanthus* **humile** LESKE, 1778.
planus = **Laganum Bonani** KLEIN, 1734, et **Scutella bifissa** LAM. 1816.

1711.

SCHYNVOET Thes. Imag. 1711, p. 2, *Pl. XIV. f. B.*

Diadema
turcarum.

1717.

MERCATI, Metallotheca, 1717.

Ananchytes.

1732.

J. P. BREYNII, De Echinis et Echinitis sive, ... 1732.

Echinometra ovalis ...... = *Echinus* **lucunter** LIN. 1758.

Echinoconus.

Echinocorys.

Echinanthus

vertice ...... = **Scutum ovatum** KLEIN, 1734.

Echinospatagus

cordiformis ...... = *Echinus* **cordatus** PENN. 1777.??

Echinobrissus.

Echinodiscus

dimidia ......

maximus ...... = *Echinus* **placenta** LIN. 1758.

1734.

J. T. KLEIN, Naturalis dispositio Echinodermatum, 1734.

Cidaris

miliaris esculenta! = *Cidaris esculenta* (**Leske**) 1778.

" *saxatilis*! = *Cidaris saxatilis* (**Leske**) 1778.

" *hemisphaerica* = *Cidaris* **hemisphaerica** LESKE, 1778.

" *angulosa*! = *Cidaris* **angulosa** LESKE, 1778.

variolata Rumphii Echinus setosus.

" *ellyptica*!

mammillata!

mauri.

assulata Aldrovandi Echinometra max. pel. Sardica = *Cidaris* **sardica** LESKE, 1778.

" *flammea* = *Cidaris* **flammea** LESKE, 1778.

" *variegata*! = *Cidaris* **variegata** LESKE, 1778.

" *pustulosa* = *Cidaris* **pustulosa** LESKE, 1778.

" *granulata* = *Cidaris* **granulata** LESKE, 1778.

bothryoides.

toreumatica!

Clypeus.

Fibula.

Conulus.

Discoides.

Cassis.

Galea.

Galeola.

Scutum

angulare humile! = *Echinanthus* **humile** LESKE, 1778.

ovatum.

Placenta

Mellita

laevis.

testudinata!

Laganum

Bonani!

Rumphii!

1734. KLEIN (*continued*).

Placenta
Rotula
Augusti !
Rumphii !
Arachnoides.
Cor Marinum
Spatangus
π graecum.
Spatagoides.
Ovum Marinum
Brissus
maculosus angustus ! = *Echinus* **maculosus** GMEL. 1788.
" *ventricosus* = *Spatangus* **ventricosus** LAM. 1816.
unicolor !
Brissoides.

1742.

GUALTIERI, Index testarum conchyliorum, 1742.*

Echinometra
compressa...
Echinanthus
ovalis.....
Echinodiscus
subrotundus......

1745.

C. LINNÉ, Fauna Suecica, 1745.

Echinus
subglobosus = *Echinus esculentus* LINN. 1758, non RUMPH.
subcompressus = *Echinus spatagus* LINN. 1758, non ALDROV.

1756.

LANG, Lapid. figur...... 1756.

Echinometrites.

1758.

SEBA, Locuplet. Thesaurus...... III. 1758, p. 18, *Pl. X.–XVI.*†

Echinus indigenus = *Echinus* **miliaris** MÜLL. 1771.
oblongo-rotundus = *Echinus* **lucunter** LIN. 1778.
...... *nodiformis* = *Echinus* **punctulatus** LAM. 1816.
...... *Kermesinus* = " " " "
...... *singularis* = *Echinus* **ovatus** GMEL. 1788.
indicus ...... = *Cidaris* **angulosa** LESKE, 1778.
...... *cordiformis* = *Echinus* **cordatus** PENN. 1777.
oblongus ...... = *Echinus* **maculosus** GMEL. 1788.
...... *orientalis* = **Scutum ovatum** KLEIN, 1734.

* The genera of Breynius were adopted by Gualtieri; he gave no binomial names, strictly speaking.

† Seba has no binomial names, yet as many of his names have been quoted as binomials, those only which have been used in this way are here given. (...... signifies a word left out.)

1758. SEBA (*continued*).

Echinus ...... maximus = *Echinus* **rosaceus** LIN. 1758.
americanus...... = " " " "
orientalis ...... = *Cidaris esculenta* (**Leske**), 1778.
...... purpurascens = *Echinus* **miliaris** MÜLL. 1771.
...... pergrandis = *Cidaris* **pustulosa** LESKE, 1778.
aculeatus ...... = *Echinus* **subglobosus** LIN. 1745.
Echinometra orientalis = **Cidaris mammillata** KLEIN, 1734.
nigra ......
multipes ......
purpurea ......
singularissima ...... = *Cidarites* **geranioides** LAM. 1816.
setosa ...... = *Echinometra* **setosa** RUMPH. 1705.
muscosa ...... *Cidarites* **metularia** LAM. 1816.
...... minor.
Echionanthus major ...... = *Cidaris* **radiata** LESKE, 1778.
...... maximus = *Echinus* **grandis** GMEL. 1788.
maximus ...... = *Echinodiscus* **auritus** LESKE, 1778.
Echinus laganoides ...... = **Mellita testudinata** KLEIN, 1734.
planus ...... = *Echinanthus* **humile** LESKE, 1778.
Echinodiscus minuscula = **Rotula Rumphii** KLEIN, 1734.
minima ......
Echinus scutiformis ...... = *Echinus* **reticulatus** LIN. 1758.
...... ellipticus = **Brissus unicolor** KLEIN, 1734.

1758.

LINNÉ, Systema Naturae Ed. decima ref. 1758.

Echinus
esculentus non RUMPH. = *Echinus* **subglobosus** LINN. 1745.
globulus.
sphaeroides.
lixula.
saxatilis (**Linn.**) non RUMPH. = *Echinus* **lividus** LAM. 1816.
diadema.
cidaris.
mammillatus.
lucunter.
atratus.
spatagus non ALDROV. = *Echinus* **subcompressus** LINN. 1745.
lacunosus.
rosaceus.
reticulatus.
placenta.
orbiculus.

1764.

PETIVER, Gazophylacii Nat. et Artis Decades, 1764.

Echinus
setosus.
perexiguus = **Spatagus pusillus** MÜLL. 1776.
Echinometra
digitata = *Cidarites* **metularia** LAM. 1816.

1771.

P. L. S. Müller, Deliciae Naturae, ... Knorr, 1771.

Echinus

miliaris.

Echinometra

setosa (**Mull.**) non Rumph. = **Spatagus pusillus** Müll. 1776.

1774.

Pallas, Spicilegia Zoologica, Fas. IX. 1774.

Echinus

calamaris.

minutus.

1774.

Van Phelsum, Brief ...... 1774.

Echinonëus.

Echinocyamus.

1776.

O. F. Muller, Prodromus Zool. Dan. 1776.

Echinus

sphaera ! ? = *Echinus* **subglobosus** Lin. 1745.

Drobachiensis ! ?

saxatilis ! ? non Rumph. nec Lin. = *Echinus* **miliaris** Müll. 1771.

Spatagus (err. typ.) **Spatangus** Klein, 1734.

flavescens ! ?

pusillus ! ?

purpureus ! ?

Pedicellaria.

1777.

Pennant, British Zoology, IV. 177., p. 58, *Pl. XXXIV. f. 2.*

Echinus

cordatus.

1778.

Leske, Additamenta ad Klein, ... 1778.

Latin Translations of Van Phelsum's names.

*Echinosinus.**

Echinites.

Echinodiscoides.

Echinoplacos.

Echinomitra.

Echinorodum.

Amygdala.

* These names are universally attributed to Van Phelsum. Lütken first showed that Van Phelsum only proposed two genera, **Echinonëus** and **Echinocyamus**, Leske giving Latin names, without adopting them however, to the subdivisions of Van Phelsum which had received from him only vernacular appellations. Agassiz, Gray, and other writers have even quoted Van Phelsum for specific names, these are also nothing but Leske's Latin translations of Van Phelsum's names, as in the case of the genera ; they are here given as they appear.

1778. Leske (*Latin translations continued*).

Ova.
Nuces.
Campana.
Echinocardium.
Echinophora.
Echinus coniformis = *Cidaris esculenta* (**Leske**), 1778.
  decemradiatus = " " " "
Carduum marinum = *Cidaris* **Basteri** Leske, 1778.
Echinus pentagonus = *Cidaris* **angulosa** Leske, 1778.
Echinometra subrotunda = *Cidarites* **metularia** Lam. 1816.
  latefasciata = *Cidarites* **imperialis** Lam. 1816.
Cometa parva = *Cidaris* **stellata** Leske, 1778.
  magna = *Cidaris* **radiata** Leske, 1778.
Echinometra violacea = *Echinus* **atratus** Lin. 1758.
Echinoglycus irregularis = **Mellita laevis** Klein, 1734.
Echinotrochus perforatus = *Echinodiscus* **sexiesperforatus** Leske, 1778.
Echinoglycus frondosus = *Echinodiscus* **emarginatus** Leske, 1778.
  auritus = *Echinodiscus* **auritus** Leske, 1778.
  inauritus = *Echinodiscus* **auritus** Leske, 1778.
  oblique = *Echinodiscus* **emarginatus** Leske, 1778.
  pentagonus = *Echinus* **reticulatus** Lin. 1758.
  ovalis = *Echinus* **reticulatus** Lin. 1758.
Echinotrochus octodigitatus = **Rotula Augusti** Klein, 1734.

1778.

N. P. Leske, Addit. Klein, 1778.

Cidaris
  esculenta (**Leske**) non Rumph. nec Lin.
  saxatilis " " " = *Echinus* **miliaris** Müll. 1771.
  Basteri.
  hemisphaerica.
  angulosa.
  diadema.
Cidarites.
Cidaris
  subangularis.
  fenestrata pars = *Echinus* **atratus** Lin. 1758.
  lucunter.
  rupestris.
  calamaris.
  araneiformis.
  stellata.
  radiata.
  violacea = *Echinus* **atratus** Lin. 1758.
  papillata.
  sardica.
  flammea.
  variegata.
  pustulosa.
  granulata = *Echinus* **globulus** Lin. 1758.

1778. LESKE (*continued*).

Echinoneus
cyclostomus.
minor.
Echinocorytes
Echinanthus
humile.
ovatus.
Echinanthites.
Echinodiscus
bisperforatus = **Mellita laevis** KLEIN, 1734.
quinquiesperforatus = **Mellita testudinata** KLEIN, 1734.
sexiesperforatus.
emarginatus.
auritus
inauritus = *Echinodiscus* **auritus** LESKE, 1778.
quaterperforatus = *Echinodiscus* **emarginatus** LESKE, 1778.
laganum = **Laganum Bonani** KLEIN, 1734.
reticulatus.
orbicularis.
deciesdigitatus = **Rotula Augusti** KLEIN, 1734.
octiesdigitatus = " " " "
dentatus = **Rotula Rumphii** KLEIN, 1734.
Echinocyamus
nucleo cerasi = *Echinus* **minutus** PALL. 1774.
ervum = " " " "
vertice centrali = " " " "
craniolaris = " " " "
turcicus = " " " "
vicia = **Spatagus pusillus** MÜLL. 1776.
ovatus = *Echinus* **minutus** PALL. 1774.
lathyrus = " " " "
equinus = " " " "
angulosus = **Spatagus pusillus** MÜLL. 1776.
ovalis = " " " "
inaequalis = *Echinus* **minutus** PALL. 1774.
cor ranae = " " " "
cor raninum = " " " "
Echinarachnius
placenta.
Spatangus
lacunosus.
pusillus.
purpureus.
Brissus
" *var. maculosus.*
" " *unicolor.*
" " *ovatus.*
" " *late carinatus* = *Echinus* **carinatus** GMEL. 1788.
ovatus.
Spatangites.

1780.

FABRICIUS, Fauna Groenland. 1780, No. 368.

Echinus

saxatilis non RUMPH. nec LIN. nec MÜLL. = *Echinus* **Dröbachiensis** MÜLL. 1776.

1782.

MOLINA, Saggio sulla storia naturale del Chili, 1782.

Echinus

albus.

niger (**Mol.**) non RUMPH.

1782.

BONANNI, Rer. Nat. Historia, 1782, p. 9, *Pl. VI. f. 33.*

Echynus (err. typ.) **Echinus.**

complanatus = **Laganum Bonani** KLEIN, 1734.

1788.

GMELIN, LINN. Syst. Nat. 1788.

Echinus

Basteri.
hemisphaericus.
angulosus.
gratilla.
subangularis.
fenestratus.
araneiformis.
stellatus.
radiatus.
assulatus.
sardicus.
flammeus.
variegatus.
pustulosus.
granulatus.
toreumaticus.
cyclostomus.
semilunaris = *Echinoneus* **minor** LESKE, 1778.
scutiformis non VAN PHEL. = *Echinus* **reticulatus** LIN. 1758 (pars).
oviformis = **Scutum ovatum** KLEIN, 1734.
biforis = **Mellita laevis** KLEIN, 1734.
pentaporus = **Mellita testudinata** KLEIN, 1734.
hexaporus = *Echinodiscus* **sexiesperforatus** LESKE, 1778.
emarginatus.
auritus.
inauritus.
tetraporus = *Echinodiscus* **emarginatus** LESKE, 1778.
laganum.
orbicularis.
decadactylos = **Rotula Augusti** KLEIN, 1734.
octodactylos = " " " "
nucleus = *Echinus* **minutus** PALL. 1774.
centralis = " " " "

1788. GMELIN (*continued*).

Echinus

ervum.
craniolaris.
turcicus.
vicia.
ovulum = *Echinus* **minutus** PALL. 1774.
lathyrus.
equinus.
faba = *Echinus* **minutus** PALL. 1774.
inaequalis.
raninus = *Echinus* **minutus** PALL. 1774.
bufonius = " " " "
purpureus.
pusillus.
maculosus.
major = *Echinus* **maculosus** GMEL. 1788.
nodosus.
orthopetalus = **Brissus unicolor** KLEIN, 1734.
unicolor.
ovatus.
carinatus.
grandis.

1789.

ABILDGAARD, Zoöl. Danica, 1789.

Spatangus

pusillus !? non LESKE nec MÜLL. Prod.
flavescens.

1801.

LAMARCK, Système des Animaux sans Vertèbres, 1801.

Galerites.
Nucleolites.
Cassidulus
caribæarum !
Clypeaster
rosaceus !
pentaporus !

1812.

PENNANT, British Zoölogy, 2d Ed. 1812, p. 140, *Pl. XXXVIII. f. 1-4.*

Echinus

pulvinulus = **Spatagus pusillus** MÜLL. 1776.

1815.

LEACH, Zoöl. Miscell. II. 1815, p. 68, *Pl. LXXXII.*

Spatangus.

Australasiae.

1816.

LAMARCK, An. s. Vert. 1816.

Scutella

dentata !
digitata ! = **Rotula Augusti** KLEIN, 1734.
emarginata !
sexforis ! = *Echinodiscus* **sexiesperforatus** LESKE, 1778.
quinquefora ! = **Mellita testudinata** KLEIN, 1734.
quadrifora = *Echinodiscus* **emarginatus** LESKE, 1778.
bifora ! = **Mellita laevis** KLEIN, 1734.
bifissa = *Echinodiscus* **auritus** LESKE, 1778.
orbicularis ! (**Lamk.**) non LESKE.
placenta !
parma !
placunaria ! = *Echinanthus* **humile** LESKE, 1778.
latissima !
ambigena ! = *Echinanthus* **humile** LESKE, 1778.

Clypeaster

scutiformis !
laganum !
oviformis !

Fibularia

trigona !? = *Echinus* **minutus** PALL. 1774.
ovulum !
tarentina !? = **Spatagus pusillus** MÜLL. 1776.

Echinoneus

semilunaris !
gibbosus ! = *Echinoneus* **cyclostomus** LESKE, 1778.

Spatangus

pectoralis ! = *Echinus* **grandis** GMEL. 1788.
ventricosus !
carinatus !
columbaris ! = *Echinus* **ovatus** GMEL. 1788.
compressus ! = *Echinus* **maculosus** GMEL. 1788.
Crux Andreae ! = *Spatangus* **Australasiae** LEACH, 1815.
sternalis !
planulatus !
canaliferus ! = *Echinus* **lacunosus** LIN. 1758.
atropos !
arcuarius ! = *Echinus* **cordatus** PENN. 1777.

Cassidulus

australis ! = **Cassidulus caribæarum** LAMK. 1801.

Echinus

ventricosus ! = *Cidaris esculenta* (**Leske**), 1778.
granularis !?
virgatus !? = *Cidaris* **sardica** LESKE, 1778.
globiformis ! = *Echinus* **subglobosus** LIN. 1745.
fasciatus ! = *Cidaris* **sardica** LESKE, 1778.
pileolus !
melo !
acutus !
pentagonus ! = *Cidaris* **sardica** LESKE, 1778.

1816. LAMARCK (*continued*).

Echinus

obtusangulus ! = *Echinus* **pileolus** LAM. 1816.
polyzonalis ! = " " " "
maculatus !
variolaris !
margaritaceus !
sculptus ! = **Cidaris toreumatica** KLEIN, 1734.
punctulatus !
ovum !
pallidus !
variegatus ! (**Lam.**) non LESKE.
subangulosus ! = *Cidaris* **angulosa** pars LESKE, 1778.
subcoeruleus ! = *Cidaris* **sardica** LESKE, 1778.
neglectus ! = *Echinus* **Dröbachiensis** MÜLL. 1776.
lividus ! = *Echinus saxatilis* (**Lin.**) 1758, non RUMPH. nec MÜLL.
tuberculatus !
lucunter ! (**Lam.**) non LIN.
trigonarius !

Cidarites

imperialis !
pistillaris ! = *Cidarites* **baculosa** LAMK. 1816.
hystrix ! = *Cidaris* **papillata** LESKE, 1778.
baculosa !
geranioides !
tribuloides !
metularia !
verticillata !
tubaria !
bispinosa !
annulifera !
spinosissima ! = **Diadema turcarum** SCHYN. 1711.
calamaria !
subularis ! = **Diadema turcarum** SCHYN. 1711.
diadema ! (**Lam.**) non LIN.
pulvinata !
radiata !

1817. ?

FLEMING, Wern. Mem. 1817 ?, II. 246.

Echinus

miliaris non MÜLL. nec RISSO = *Echinus* **acutus** LAM. 1816.

1820.

DE FRANCE, Article Fibulaire, Dict. Scienc. Nat. XVI. 1820.

Fibularia

nucleum.
craniolaris.
turcicus.
vicia.

1820. DE FRANCE (*continued*).

Fibularia
ovatus.
latyrus (err. typ.) **lathyrus.**
angulosa
minutus.
ovalis.
inaequalis.

1824.

EUDES DESLONGCHAMPS, Enc. Méth. Vers. II. 1824.

Echinus
solaris Val. = **Rotula Rumphii** KLEIN, 1734.
hura.
margaritaceus non LAM. = *Cidaris* **pustulosa** LESKE, 1778.
punctiferus = *Echinus* **globulus** LIN. 1758.
attenuatus.
elegans = **Cidaris toreumatica** KLEIN, 1734.
Cassidulus
Richardii = **Cassidulus caribæarum** LAM. 1801.
Fibularia
nucleola = *Echinus* **minutus** PALL. 1776.
Scutella
integra.
porpita = *Echinus* **placenta** LIN. 1758.

1824.

FLEMING, Wern. Mem. 1824, V. 287.

Spatangus
ovatus non LESKE, nec LAM. = **Spatagus flavescens** MÜLL. 1776.

1825.

BLAINVILLE, Dict. Scienc. Nat. ...... Oursin, 1825.

Echinus
loculatus ! = *Cidaris* **pustulosa** LESKE, 1778.
stellatus ! (**Blainv.**) non GMEL.
aequituberculatus !
Dufresnii !
pseudomelo ! = *Echinus esculentus* (**Lin.**) 1758, non RUMPH.
quinqueangulatus ! ? " " " " " "
auranticus ! ? " " " " " "
violaceus ! ? " " " " " "
paucituberculatus ! = *Echinus* **variolaris** LAM. 1816.
minimus ! = *Cidaris* **angulosa** LESKE, 1778.
excavatus ! = *Echinus variegatus* (**Lam.**) 1816, non LESKE.
trizonalis ! = *Echinus* **pileolus** LAM. 1816.
depressus ! = *Echinus* **maculatus** LAM. 1816.
vulgaris ! ? = *Echinus saxatilis* (**Lin**) 1758, non Rumph. nec MÜLL.
Gaimardi !
equituberculatus ! = *Echinus* **granularis** LAM. 1816.
dubius ! ? = " " " "

1825. BLAINVILLE (*continued*).

Echinus

microtuberculatus !
molaris ! = *Echinometra* **setosa** RUMPH. 1705.
longispina ! = *Echinometra* **setosa** RUMPH. 1705.
subglobiformis ! = *Echinus* **granularis** LAM. 1816.
inflatus ! = *Cidaris* **variegata** LESKE, 1778.
Peronii ! = " " " "
Leschenaulti ! = *Echinus* **variolaris** LAM. 1816.
Maugei ! = *Echinus lucunter* (**Lam.**) 1816. non LIN.
Mathaei ! = " " " " "
acufer ! = *Echinus* **lucunter** LIN. 1758.
oblongus !
lobatus !? = *Echinus* **lucunter** LIN. 1758.
Quoy ! = *Echinus* **atratus** LIN. 1758.
pedifer ! = " " " "

1825.

DELLE CHIAJE, Mem. s. Stor. e. Not. degl. An. senz. Verteb. 1825, *December*.

Echinus

neapolitanus = *Cidaris* **pustulosa** LESKE, 1778.
spatagus non LIN. = **Brissus unicolor** KLEIN, 1734.
ventricosus non LAM. = *Echinus* **melo** LAM. 1816.

1825.

J. E. GRAY,...... Ann. Phil. 1825.

Cidaris

imperialis !

Diadema

setosa ! (**Gray**) non RUMPH.
calamaria !

Astropyga

radiata !

Echinometra

lucunter !
mammillata !
atrata !

Echinanthus

rosaceus !
subdepressa !
ambigena.

Lagana (err. typ.) **Laganum** KLEIN, 1734.

laganum !
scutiformis !
minor.

Echinarachnius

parma !

1825. GRAY (*continued*).

Echinodiscus
bifora !
digitata !
octodactylus !
Echinocyamus
ovulum
pusillus !
tarentina
trigona
Discoidea (err. typ.) **Discoides** KLEIN, 1734.
Echinanaus (err. typ.) **Echinonëus** VAN PHEL. 1774.
cyclostomus !
Echinolampas
oviformis !
orientalis = **Scutum ovatum** KLEIN, 1734.
Echinocardium
atropos !
pusillus
Seba ! = *Echinus* **cordatus** PENN. 1777.
Brissus
ventricosus !
carinatus !
columbaris !
Ova
canaliferus !

1826.

RISSO, Hist. Nat. Prod. Europ. Mérid. 1826, V. p. 276.

Echinus
sardicus non GMEL. nec LAM. = *Echinus* **melo** LAM. 1816.
miliaris non MÜLL. nec FLEM. = *Echinus* **microtuberculatus** BLAINV. 1825.
purpureus non MÜLL. nec GMEL. = *Echinus saxatilis* (**Lin.**) 1758, non RUMPH.
brevispinosus = *Echinus* **granularis** LAM. 1816.
Spatangus
carinatus non LAM. = **Brissus unicolor** KLEIN, 1734.
meridionalis = **Spatagus purpureus** MÜLL. 1776.

1827.

BLAINVILLE, Article Scutelle, Dict. Scienc. Nat. 1827, XLVIII.

Scutella
Rumphii !
semisol ! = **Rotula Rumphii** KLEIN, 1734.
decadactylos.
octodactylos.
reticulatus.
laganum !
clypeastriformis ! ? = *Echinus* **reticulatus** LIN. 1758.
decagonalis LESS. !

1827.

BLAINVILLE, Article Spatangue, Dict. Scienc. Nat. 1827, L. p. 87.

Spatangus

grandis

Gualterii = *Echinus* **lacunosus** GMEL. 1788.

1827.

SAY, Journ. Acad. Phila. 1827, p. 225.

Echinus

granularis!? non LAM. = *Echinus* **Drobachiensis** MÜLL. 1776.

Scutella

pentaphora!? = **Mellita testudinata** KLEIN, 1734.

trifaria!? = **Scutella parma** LAM. 1816.

1828.

FLEMING, Brit. Anim. 1828.

Echinus

subangularis non LESKE = *Echinus* **Dröbachiensis** MÜLL. 1776.

Spatangus

cordatus.

1830.

BLAINVILLE, Zoophytes Dict. Scienc. Nat. 1830, LX.

Spatangus

unicolor.

Echinoclypeus.

Echinocyamus

minutus!?

Lagana

ovalis! = *Echinus* **scutiformis** GMEL. 1778.

orbicularis!

decagona LESS. (err. typ.) *Scutella* **decagonalis** LESS.

Clypeaster

ambigenus!

Echinodiscus

placunaria!

latissima!

placenta!

parma!

Rumphii!

Scutella

hexapora!

pentapora! = **Mellita testudinata** KLEIN, 1734.

biforis!

tetrapora.

aurita!

inaurita!

octodactyla!

decadactyla.

radiata! = **Rotula Rumphii** KLEIN, 1734.

1830. BLAINVILLE (*continued*).

Echinometra

Leschenaulti !
Maugei !
Mathaei !
acufera !
oblonga !
lobata !
Quoyii !
pedifera !
carinata !
trigonaria !

Echinus

parvituberculatus = *Echinus* **microtuberculatus** BLAINV. 1825.
mola (err. typ.) **molaris** BLAINV. 1825.
minutus (err. typ.) **minimus** BLAINV. 1825.
quinqueangulosus (err. typ.) **quinqueangulatus** BLAINV. 1825.

Cidaris

hystrix !
geranioides !
pistillaris !
calamaria !
metularia !
tribuloides !

1833. ?

ESCHSCHOLTZ, Zoöl. Atl. ...... 1833 ?, *Pl. XX. f. 1, 2.*

Scutella

excentrica.
quinqueloba = *Echinodiscus* **emarginatus** LESKE, 1778.

1835.

J. E. GRAY, Proc. Zoöl. Soc. London, 1835, *April.*

Arbacia

pustulosa.
punctulata !
loculata.
stellata.
equituberculata (err. typ.) *aequituberculata.*
Dufresnii.

Salenia.

Echinometra

miliaris !
paucituberculata.
minuta.
ovum.
pallida.
grisea.
livida.
parvituberculata.
mola.
longispina.
subglobiformis.
variolaris.
tuberculata.

1835.

BRANDT, Prodromus, ... 1835, *May.*

Echinus

Strongylocentrotus

chlorocentrotus ! = *Echinus* **Dröbachiensis** MÜLL. 1776.

lividus.

parvituberculatus.

mola.

longispina.

subglobiformis.

tuberculatus.

Heterocentrotus

carinatus.

Postellsii = **Cidaris mammillata** KLEIN, 1734.

trigonarius.

mammillatus.

taeniatus = *Echinus* **trigonarius** LAM. 1816.

Colobocentrotus

Mertensii.

Leskei = *Echinus* **atratus** LIN. 1758.

Quoyi.

pedifer.

Cidarites

Phyllacanthus

dubia.

imperialis.

hystrix.

geranioides.

pistillaris.

tribuloides.

1835.

DESMOULINS, Tableau Analytique, 1835, *July.*

Pyrina.

Echinocidaris.

Collyrites.

1836.

L. AGASSIZ, Prodrome, 1836, *July.*

Echinocrinus.

Dysaster.

Holaster.

Hemipneustes.

Micraster

canaliferus !

lacunosus

Amphidetus

Sebae

pusillus.

Brissus

pectoralis !

1836. L. AGASSIZ (*continued*).

Brissus
Scillae ! = **Brissus unicolor** KLEIN, 1734
compressus !
sternalis !
Schizaster
atropos !
Catopygus.
Pygaster.
Clypeaster
subdepressus.
Echinarachnius
placunarius !
latissimus !
Rumphii !
Diadema
spinosissimum
subulare !
pulvinatum !
Cidaris
annulifera !

1836.

MILNE-EDWARDS, Cuv. Règ. An. Ed. Ill. 1836.

Nucleolites
recens !

1837.

DESMOULINS, Tableaux Syn. 1837.

Clypeaster
incurvatus = *Echinus* **reticulatus** LIN. 1758 (pars).
rangianus = *Echinanthus* **subdepressus** GRAY, 1825.
reticulatus.
Rumphii = *Echinanthus* **humile** LESKE, 1778.
Scutella
bifora non LAM. = **Mellita laevis** KLEIN, 1734.
bilinearifora = **Scutella bifora** LAM. 1816.
cassidulina = *Echinodiscus* **emarginatus** LESKE, 1778.
Fibularia
australis.
Galerites
echinonea = *Echinoneus* **cyclostomus** LESKE, 1778.
Echinometra
Blainvillii = **Cidaris mammillata** KLEIN, 1734.
pugionifera = *Echinus* **trigonarius** LAM. 1816.
subangularis.
Postelsii.
Mertensii.
Echinus
Blainvillii = *Echinus variegatus* (**Lam.**) 1816, non LESKE.
auguifer = *Echinus* **variolaris** LAM. 1816.
Echinocidaris
pustulosa.

1837. DESMOULINS (*continued*).

Echinocidaris
punctulata.
loculata. !
stellata.
aequituberculata.
Dufresnii.
Diadema
stellatum.
Desmarestii = *Echinus* **variolaris** LAM. 1816.
radiatum.
Cidaris
dubia.
Echinolampas
Richardi (**Desml.**) non DESMT. = *Echinolampas* **Hellei** VAL. 1869 in PERR.
Nucleolites
Richardi.
Spatangus
Rumphii = *Echinus* **maculosus** GMEL. 1788.
Reaumurii = *Echinus* **cordatus** PENN. 1777.

1838.

L. AGASSIZ, Mon. Éch. Salén. 1838.

Goniopygus.
Peltastes.
Goniophorus.

1839.

L. AGASSIZ, Échin. Foss. Suiss I. 1839.

Pygorhynchus.
Conoclypus.
Pygurus.
Hyboclypus.

1840.

MCCLELLAND, Calcu. Journ. N. H. I. 1840, p. 155, *July.*

Cyrtoma.

1840.

J. E. GRAY, Syn. Cont. Brit. Mus. 1840, *November.*

Hipponoë.
Colobocentrus (err. typ.) **Colobocentrotus** BRANDT, 1835.
Heterocentrus (err. typ.) **Heterocentrotus** BRANDT, 1835.

1840.

L. AGASSIZ, Échin. Suiss. II. 1840.

Tetragramma.
Acrocidaris.
Pedina.

1840. L. AGASSIZ (*continued*).

Acrosalenia.
Hemicidaris.
Arbacia (**Agass.**) non GRAY.
Glypticus.

1840.

L. AGASSIZ, Cat. Syst. Ectyp. 1840.

Toxaster.
Brissopsis.
Nucleopygus.
Globator.
Caratomus.
Amblypygus.
Heliophora.
Amphiope.
Encope
  grandis.
Echinopsis.
Cyphosoma (**Agass.**) non MANN. 1837.
Acropeltis.
Coelopleurus.
Codiopsis.
Podophora
  atrata !
Acrocladia
  mammillata !

1841.

GOULD, Rep. Inv. Mass. 1841, p. 344.

Echinus
  granulatus ! non GMEL. = *Echinus* **Dröbachiensis** MÜLL. 1776.

1841.

FORBES, British Starfishes, 1841.

Echinus
  Flemingii ! ? BALL = *Echinus* **acutus** LAM. 1816.
Brissus
  lyrifer ! ?
Amphidotus (err. typ.) **Amphidetus** AGASS. 1836.
  cordatus ! ?
  roseus ! ? = **Spatagus flavescens** MÜLL. 1776.

1841.

SISMONDA, Mém. Acad. Turin. 1841.

Anaster.

1841.

L. AGASSIZ, Int. Mon. Scut. 1841, *July*.

Temnopleurus
toreumaticus !
Cidaris
bothryoïdes (**Agass.**) non KLEIN,
Pleurechinus
bothryoides !
Echinus
versicolor ! VAL. = *Echinus* **globulus** LIN. 1758.
Microcyphus
versicolor !
Tripneustes
ventricosus !
Amblypneustes
griseus !
Toxopneustes
pileolus !
Stomopneustes
variolaris !
Tetrapygus.
Agarites.

1841.

L. AGASSIZ, Mon. Scut. 1841.

Rotula
digitata !
Runa
Mellita
quinquefora !
hexapora !
similis ! = *Echinus* **hexaporus** GMEL. 1788.
lobata ! = *Echinodiscus* **emarginatus** LESKE, 1778.
Encope
emarginata !
tetrapora ! (**Agass.**) non LESKE, nec GMEL. = *Encope* **micropora** AGASS. 1841.
micropora !
perspectiva ! = *Encope* **micropora** AGASS. 1841.
cyclopora = " " " "
oblonga ! = *Echinodiscus* **emarginatus** LESKE, 1778.
Valenciennesii = " " " "
subclausa ! = " " " "
Michelini !
Stokesii !
Lobophora (**Agass.**) non CURT. nec SERV.
bifora !
truncata ! = **Mellita laevis** KLEIN, 1734.
bifissa !
aurita !
Echinarachnius
atlanticus ! GRAY = **Scutella parma** LAM. 1816.

1841. L. Agassiz (*continued*).

Arachnoides
placenta !
Scutellina.
Laganum
depressum ! Less.
ellipticum = *Laganum* **depressum** Less. 1841.
decagonum ! = *Scutella* **decagonalis** Less. 1827.
Tonganense ! Q. G. = *Laganum* **depressum** Less. 1841.
Lesueuri ! Val. = *Scutella* **decagonalis** Less. 1827.
elongatum !
rostratum !
orbiculare !
marginale ! = *Echinodiscus* **orbicularis** Leske, 1778.
stellatum ! = *Laganum* **Peronii** Agass. 1841.
Peronii !
Moulinia
cassidulina !

1841.

L. Agassiz, Introd. Valent. Anat. Genre Echinus, 1841, *December.*

Echinus
albidus ! = *Echinus saxatilis* (**Lin.**) 1758, non Rumph.
pustulatus ! = *Echinus* **miliaris** Müll. 1771.
pulchellus ! = *Echinus* **microtuberculatus** Blainv. 1825.
decoratus ! = " " " "
Microcyphus
maculatus !
Salmacis
bicolor !
Tripneustes
subcoeruleus !
obtusangulus !
Amblypneustes
ovum !
Cidaris
granulata ! (**Agass.**) non Leske.
Holopneustes
granulatus !
Toxopneustes
tuberculatus !

1842.

Desor, Agass. Mon. Éch. Galérites, 1842.

Echinoneus
cruciatus ! Agass. = *Echinoneus* **cyclostomus** Leske, 1778.
elegans ! = *Echinoneus* **minor** Leske, 1778.
serialis ! = *Echinoneus* **cyclostomus** Leske, 1778.
conformis ! = *Echinoneus* **minor**, Leske, 1778.
Holectypus.

1842.

RAVENEL, J. A. N. Scienc. Phila. 1842, p. 333.

Scutella

caroliniana = *Echinodiscus* **sexiesperforatus** LESKE, 1778.

1843.

J. E. GRAY, Deiff. Voy. II. 1843, p. 265.

Echinarachnius

zelandiae ! ? = *Echinus* **placenta** LIN. 1758.

1843.

CONRAD, Proc. Phila. Ac. N. Sc. 1843, p. 327.

Spatangus

orthonotus = *Echinocardium* **pennatifidum** NORM. 1867 ?

1844.

L. AGASSIZ, Bull. Soc. Géol. Fr. 1844, p. 730, *August.*

Metaporhinus.

1844.

McCOY, Synopsis Carb. Lim. foss. Ireland, 1844, p. 173.

Palaechinus SCOUL.
Archeocidaris.
Diplopodia.

1844.

FORBES, Proc. Lin. Soc. 1844, p. 183, *January.*

Amphidetus

mediterraneus.

1844.

MICHELIN, Rev. Mag. Zoöl. 1844, p. 173, *Mai.*

Diadema

Desjardinsii ! = **Diadema turcarum** SCHYN. 1711.

1844.

DÜBEN och KOREN, Öfvers. af K. Vetensk. Ak. Forh. 1844.

Cidaris

borealis ! = *Cidaris* **papillata** LESKE, 1778.

1845.

MICHELIN, Rev. Mag. Zoöl. 1845, *January.*

Diadema

Savignyi ! = *Diadema setosa* (**Gray**,) 1825, non Rumph.

Cidarites

papillaris ! = *Cidarites* **baculosa** LAM. 1816.

1845.

PHILIPPI, Wieg. Archiv. I. 1845.

Spatangus
Tripylus
excavatus !
cavernosus !
australis !
Brissus
pulvinatus = *Brissus* **lyrifer** FORBES, 1841.
placenta = **Brissus unicolor** KLEIN, 1734.
Cidaris
affinis = *Cidaris* **papillata** LESKE, 1778.
Diadema.
tenuispina = *Cidarites diadema* (**Lam.**) 1816.
longispina ! ?
antillarum = *Cidarites diadema* (**Lam.**) 1816.

1845.

RAVENEL, Jour. A. N. S. Phila. 1845, p. 253.

Scutella
gibbosa ! non RISSO nec SERRES. = *Echinanthus* **subdepressus** GRAY, 1825.

1845.

J. E. GRAY, in Eyre, Voyage, I. 1845, p. 436.

Spatangus
subcarinatus !
elongatus !

1846.

DÜBEN OCH. KOREN, Skand. Ech. 1846.

Echinus
norvegicus !
elegans ! (**Düb. Kor.**) non DESL. 1824.
virens ! = *Echinus* **miliaris** MÜLL. 1771.
Brissus
fragilis !

1846.

OWEN and NORWOOD, Sill Journ. 1846, p. 225, *September.*

Melonites.

1846.

J. MÜLLER, Müll. Archiv, 1845, p. 101.

Pluteus.

1846.

VALENCIENNES, Voyage Vénus, Zooph. 1846, *Pls.* ......

Agassizia
scrobiculata !
Amblypneustes
pallidus !
formosus

1846. VALENCIENNES (*continued*).

Echinus

porosus ! = *Echinus* **albus** MOL. 1782.
omalostoma = *Echinus* **tuberculatus** LAM. 1816.
eurythrogrammus !
chloroticus !

Agarites

purpurescens ! = *Echinus niger* (**Mol.**) 1782.
spatuliger !
grandinosus ! = *Cidaris* **pustulosa** LESKE, 1778.

Echinarachnius

excentricus !

1846.

L. AGASSIZ ET DESOR, Cat. Rais. Ann. Sc. Nat. 1846, p. 305, *November*.

Cidaris

Stokesii ! AG. = *Cidaris* **papillata** LESKE, 1778.
Thouarsii ! VAL.
Danae ! AG. = *Cidaris* **Thouarsii** VAL.
Lima ! AG. = *Cidarites* **baculosa** LAM. 1816.
Krohnii ! AG. = " " " "

Goniocidaris DES.

geranioides ! AGASS.
Quoyi ! VAL. = *Cidarites* **tubaria** LAM. 1816.

Palaeocidaris DES.

Astropyga

pulvinata ! AG.
calamaria ! AG.
Desorii ! AG.
spinosissima ! AG.
subularis ! AG.

Diadema

europaeum ! AG. = *Diadema* **longispina** PHIL. 1845.
turcarum ! non SCHYN. = *Cidarites diadema* (**Lam.**) 1816.
Lamarckii ! ROUSS. = *Diadema setosa* (**Gray**), 1825.

Hemidiadema AG.

Echinocidaris

Agarites

punctulata ! AG.
stellata ! AG.
Dufresnii ! AG.
loculata ! AG.

Tetrapygus

niger ! AG.
aequituberculatus ! AG.
pustulosus ! AG.
grandinosus ! AG.

Eucosmus AG.

Mespilia DES.

globulus ! AG.

1846. L. Agassiz et Desor (*continued*).

Microcyphus
Rousseaui ! Ag. = *Microcyphus* **maculatus** Agass. 1841.
zigzag ! Ag.
Salmacis
sulcatus ! Ag.
virgulatus ! Ag. = *Salmacis* **sulcatus** Ag. 1846.
rarispinus ! Ag.
varius ! Ag. = *Salmacis* **rarispinus** Ag. 1846.
Dussumieri ! Ag.
globator ! Ag.
Temnopleurus
Reynaudi ! Ag.
bothryoides ! Ag.
Polycyphus Ag.
Amblypneustes
textilis ! Ag. = *Echinus* **ovum** Lam. 1816.
scalaris ! Ag. = *Amblypneustes* **formosus** Val. 1846.
serialis !? Ag. = *Echinus* **ovum** Lam. 1816.
Boletia Des.
pileolus ! Des.
heteropora ! Des. = *Echinus* **pileolus** Lam. 1816.
maculata ! Des.
bizonata ! Des. = *Echinus* **pileolus** Lam. 1816.
Tripneustes
sardicus ! Ag.
pentagonus ! Ag.
Holopneustes
porosissimus ! Ag. = *Cidaris granulata* (**Agass.**) 1841, non Leske.
Echinus
Toxopneustes
brevispinosus !
granularis !
Dröbachiensis !
albidus ! Ag.
lividus !
concavus ! Ag. = *Echinus saxatilis* (**Lin.**) 1758.
gibbosus ! Val.
Delalandi ! Val. = *Echinus* **eurythrogrammus** Val. 1846.
neglectus ! = *Echinus* **Dröbachiensis** Müll. 1776.
complanatus ! Val. = *Echinus* **lividus** Lam. 1816.
granulatus ! Ag.
Dubenii Ag. = *Echinus* **Dröbachiensis** Müll. 1776.
Psammechinus
variegatus !
semituberculatus ! Val.
subangulosus !
norvegicus !
miliaris !
microtuberculatus !
Korenii ! Des. = *Echinus* **miliaris** Müll. 1771.

1846. L. AGASSIZ ET DESOR (*continued*).

Echinus
Psammechinus
excavatus !
Echinus
laganoides DES. = *Echinometra* **setosa** RUMPH. 1705.
Heliocidaris DESML.
variolaris ! DESML.
paucituberculata ! DESML.
chlorotica ! DESML.
margaritacea !
eurythrogramma ! DES.
omalostoma ! DES.
mexicana ! AG. = *Echinus* **lucunter** LIN. 1758.
Echinometra
heteropora ! AG. = *Echinus lucunter* (**Lam**.) 1816.
Michelini ! DES. = *Echinus* **lucunter** LIN. 1758.
Acrocladia
trigonaria ! AG.
hastifera ! AG. = **Cidaris mammillata** KLEIN, 1734.
Blainvillei ! AG. = " " " "
Podophora
pedifera ! AG.

1847.
L. AGASSIZ, in DESOR, Bull. Soc. Géol. France. IV. 1847, p. 287.
Monophora.

1847.
DUCHASSAING, Bull. Soc. Géol. France, 1847, *June*. ? ?
Clypeaster
parvus = *Echinus* **rosaceus** LIN. 1758.
Cassidulus
guadeloupensis = **Cassidulus caribæarum** LAM. 1801.

1847.
L. AGASSIZ ET DESOR, Cat. Rais. Ann. Sc. Nat. 1847, p. 5, *March*.
Laganum
attenuatum ! AG. = *Laganum* **depressum** LESS. 1841.
cingulatum ! AG. = " " " "
latissimum !
Dendraster AG.
excentricus ! AG.
Lobophora
tenuissima ! VAL. = **Mellita laevis** KLEIN. 1734.
Mellita
nummularia ! VAL. = *Echinodiscus* **emarginatus** LESKE, 1778.
Moulinsia (err. typ.) **Moulinia** AGASS. 1841 ; non GRATEL. 1840.
Echinocyamus
australis ! AG.
Fibularia
volva ! AG.
Lenita DES.

1847. L. AGASSIZ et DESOR (*continued*).

Echinoneus
crassus ! AG. = *Echinoneus* **cyclostomus** LESKE, 1778.
ventricosus ! AG. = " " " "
Pygaulus AG.
Archiacia AG.
Asterostoma AG
Spatangus
spinosissimus !? DES. = **Spatagus purpureus** MÜLL. 1776.
Macropneustes AG.
Eupatagus AG.
Valenciennesii ! AG.
Gualteria DES.
Lovenia DES.
hystrix DES. = *Spatangus* **elongatus** GRAY, 1845.
Amphidetus
cordatus ! AG.
gibbosus ! AG. = *Amphidetus* **mediterraneus** FORBES, 1844.
ovatus ! AG.
Breynia DES.
Crux Andreae ! AG.
Brissus
Plagionotus (**Agass.**) non MULS. 1842.
pectoralis !
Brissus
ventricosus !
bicinctus ! VAL. = *Spatangus* **sternalis** LAM. 1816.
dimidiatus ! AG. = **Brissus unicolor** KLEIN, 1734.
areolatus ! VAL. = *Spatangus* **sternalis** LAM. 1816.
Brissopsis
lyrifera !
cavernosa !
australis !
Hemiaster DES.
Pericosmus AG.
Agassizia
excavata ! DES.
Schizaster
canaliferus ! AG.
fragilis ! AG.
gibberulus ! AG.
cubensis ! D'ORB. = *Spatangus* **ventricosus** LAM. 1816.
Echinolampas
Laurillardi ! (**Desml.**) 1847, non DESMT. = *Echinolampas* **Hellei** VAL.; PER. 1869.

1847.

TROSCHEL in MARTENS, Wieg. Arch. 1866, I. p. 158.*

Diploporus
pyramidatus ! = *Salmacis* **sulcatus** AG. 1846.

* *Read*, Ber. der Ges. f. Nat. H. Freunde, Berlin, 1847.

1848.

RAVENEL, Ech. So. Car. 1848, *January.*

Clypeaster

prostratus = *Echinanthus* **subdepressus** GRAY, 1825.

Mellita

ampla ! HOLMES = **Mellita testudinata** KLEIN, 1734.

caroliniana.

Brissopsis

poriferus.

Amphidetus

gothicus = *Echinus* **cordatus** PENN. 1777.

1848.

J. E. GRAY, Brit. Rad. 1848, *June.*

Echinometra

Dröbachiensis !

Echinocardium

cordatus !

ovatum !

Brissiopsis (err. typ.) **Brissopsis** AGASS. 1840.

lyrifera !

1849.

McCOY, Ann. Mag N. H 1849, p. 253.

Perischodomus.

1849.

HAIME, Ann. Sc. Nat. XII. 1849, p. 217.

Milnia.

1849.

FORBES, Q. J. Geol. Soc. London, I. 1849, p. 425.

Amphidetus

virginianus = ? *Echinocardium* **pennatifidum** NORM. 1867.

1850.

GIRARD, Proc. Bost. Soc. N. H. 1850, p. 364, *November.*

Heliechinus

Gouldii ! = *Cidaris esculenta* (**Leske**) 1778.

Melobosis

mirabilis ! = *Salmacis* **sulcatus** AG. 1846.

Psammechinus

asteroides ! = *Echinus* **chloroticus** VAL. 1846.

Echinometra

nigrina ! = *Echinus* **lucunter** LINN. 1758.

Echinocyamus

minimus ! = **Spatagus pusillus** MÜLL. 1776.

Schizaster

lachesis ! = *Spatangus* **atropos** LAM. 1816.

1850.

FORBES, Ang. Mag, N. H. VI. 1850, p. 443, *December.*

Cardiaster.

1850.

ARADAS, Monog. degli Ech. di Sicilia, Atti. Acad. Gioienia, VI. 1850, p. 55.

Amphidetus **sp. n.** = *Amphidetus* **mediterraneus** FORBES, 1844.
Schizaster
incertus = *Brissopsis lyrifera* AG. 1847.
Fibularia
equina = **Spatagus pusillus** MÜLL. 1776.

1851.

MICHELIN, Rev. Mag. Zoöl. 1851, *January*.

Encope
Agassizi ! = **Encope grandis** AG. 1841.
Haimea.

1851.

J E. GRAY, Proc. Zoöl. Soc. London, 1851, *January*.

Echinanthus
Australasiae ! = *Echinanthus* **testudinarius** GRAY, 1851.
testudinarius !
oblongus ! = *Echinus* **reticulatus** LIN. 1758.
productus ! = *Echinanthus* **humile** LESKE, 1778.
Coleae ! = *Echinus* **reticulatus** LIN. 1758.
explanatus ! = *Echinanthus* **humile** LESKE, 1778.
Echinodiscus
bifissa !
Mellita
testudinaria ! = (err. typ.) **Mellita testudinata** KLEIN, 1734.
erythraea !
Leodia
Richardsonii ! = *Echinodiscus* **sexies perforatus** LESKE, 1778.
Fibularia
oblonga ! = *Fibularia* **volva** AG. 1847.
Echinolampas
depressus !
Mortonia
australis !

1851.

HAGENOW, 1851 ?

Infulaster. (Casts distributed.)

1851.

J. E. GRAY, Ann. Mag. Nat. H. 1851, *February*.

Spatangus
Reginae ! = **Spatagus purpureus** MÜLL. 1776.
Eupatagus
similis ! = **Eupatagus Valenciennesii** AG. 1847.
Lovenia
elongata !
subcarinata !
Echinocardium
australe !
zealandicum ! = *Echinocardium* **australe** GRAY, 1851.
Breynia
Australasiae !
Desorii ! = *Spatangus* **Australasiae** LEACH, 1815.

1851. GRAY (*continued*).

Meoma
grandis!
Faorina
chinensis!
antarctica! = **Tripylus cavernosus** PHIL. 1845.
australis!
cavernosa!
Tripylus
Philippii!
Desoria (**Gray**) non AGASS. nec COTTEAU.
australis!
Schizaster
ventricosus!
Jukesii! = *Schizaster* **ventricosus** GRAY, 1851.
Kleinia
luzonica!
Agassizia
subrotunda! = **Agassizia scrobiculata** VAL. 1846.
Leskia (**Gray**) non ROB. DES.
mirabilis!

1851.

R. T. MAITLAND, Fauni Belgi. Septen. 1851.

Echinus
Basteri MAITL. non GMEL. = *Echinus* **acutus** LAM. 1816.

1851.

TROSCHEL, Wieg. Archiv. 1851, I.

Tripylus
Hamaxitus
excavatus!
Atrapus
grandis! = **Faorina chinensis** GRAY, 1851.
Abatus
cavernosus!
australis!

1852.

FORBES, Mon. Echinod. Brit. Tert. 1852, p. 5.

Temnechinus.

1852.

GIRARD, Proc. Bost. Soc. N. H. 1852, p. 213, *April.*

Amphidetus
Kurtzii! = *Echinus* **cordatus** PENN. 1777.

1853.

MICHELIN, Rev. Mag. Zoöl. 1853, *January.*

Magnosia.

1853.

DESOR, Act. Soc. Hélv. d. Scien. Nat. 1853, p. 279.

Linthia MER.
Prenaster.

1853.

PETERS, Monatsber. Akad. Berlin, 1853, *August.*

Astropyga

dubia ! = **Cidarites pulvinata** LAM. 1816.

mossambica ! = **Cidaris radiata** LESKE, 1778.

Echinothrix

calamaris !

turcarum !

subularis !

spinosissima !

Desorii !

annellata ! = *Astropyga* **Desorii** AG. 1846.

1853.

D'ARCHIAC et HAIME, Anim. foss. de l'Inde, 1853, pp. 197–214.

Glyphocyphus.
Phymosoma.
Eurhodia.
Hardouinia.

Temnopleurus

depressus ! = **Cidaris toreumatica** KLEIN, 1734.

Eupatagus

pectoralis.

1853.

D'ORBIGNY, Pal. franç. Crét. VI. 1853, pp. 175–186.

Heteraster.
Ennalaster.
Epiaster.
Insufulaster (err. typ.) **Infulaster** HAG. 1851.

1854.

D'ORBIGNY, Rev. Mag. Zoöl. 1854, p. 16, *January.*

Echinanthus

orientalis

Richardii !

oviformis !

Echinobrissus

recens !

Echinodiscus

Augusti !

1854.

MICHELIN, Rev. Mag. Zoöl. 1854, p. 439, *August.*

Grasia.

1854.

DESOR, Synops. Échin. foss. 1854, pp. 39–48.

Rhabdocidaris.
Diplocidaris.
Porocidaris.
Leiocidaris

imperialis.

1854.

D'ORBIGNY, Pal. franç. Crét. VI. 1854, p. 269

Periaster

fragilis !
gibberulus !
cubensis !

1854.

MÜLLER, J., Bau. d. Echinod. 1854.

Heterocentrus
mammillatus.
trigonarius.
Colobocentrus
atratus.
Echinanthus
rangianus.
Clypeaster
tumidulus ! = *Echinus* **reticulatus** LIN. 1758.

1855.

PETERS, Denk. Akad. Berlin, für 1854.

Centrostephanus
longispinus !

1855.

J. E. GRAY, Catal. recent Echinida, Brit. Mus. 1855, *March.*

Echinanthus
scutiformis !
placunarius !
parvus.
Laganinum (err. typ.) **Laganum** KLEIN, 1734.
latissimum !
Laganum
Peronella
Peronii !
Arachnoides
zelandiae !
Rotula
Gualteri = **Rotula Augusti** KLEIN 1734.
Echinodiscus
truncata !
tenuissima !
Mellita
testudinea (err. typ.) **Mellita testudinata** KLEIN, 1734.
Echinoglycus
frondosus ! = *Echinodiscus* **emarginatus** LESKE, 1778.
grandis !
tetrapora
perspectiva !
cyclopora !
Stokesii !
Echinocardium
Mediterraneum
gibbosum !

1855. Gray (*continued*).

Spatangus
Maretia.
planulata !
Plagionotus
Desorii !
Brissus
columbarius (err. typ.) **columbaris** Lam. 1816.
Metalia
sternalis !
Faorina
australis !
Schizaster
Nina
canalifera !
Jukesii !
ventricosa !
Brisaster
fragilis !
gibberulus !
cubensis !

1855.
J. E. Gray, Proc. Zoöl. Soc. London, 1855, pp. 35–39, *March*.

Goniocidaris
pistillaris !
Hipponöe
sardica !
Holocentronotus (err. typ.) **Heterocentrotus** Brandt.
Cidaris
ornata ! = *Cidarites* **annulifera** Lam. 1816.
annulata ! = *Cidarites* **annulifera** Lam. 1816.
spinulosa ! = *Cidarites* **tubaria** Lam. 1816.
Astropyga
depressa ! = *Cidarites* **pulvinata** Lam. 1816.
Garelia
aequalis ! = *Echinus* **calamaris** Pall. 1774.
clavata ! = *Astropyga* **Desorii** Agass. 1846.
Toreumatica
Hardwickii !
granulosa ! = *Temnopleurus* **Reynaudi** Ag. 1846.
Reevesii ! = " " " "
concava ! = *Salmacis* **Dussumieri** Ag. 1846.

1855.
D'Orbigny, Pal. franç. Crét. VI. 1855, pp. 281–374.

Claviaster.
Faujasia.
Rhynchopygus
guadeloupensis.
Stigmatopygus.
Botriopygus.
Trematopygus.

1855.

DESOR, Synops. Échin. foss. 1855, pp. 61–130.

Hypodiadema.
Pseudodiadema.
Diademopsis.
Savignya *
subularis.
spinosissima.
calamaria.
Desorii.
Asteropyga (err. typ.) **Astropyga** GRAY, 1825.
Coptosoma.
Opechinus.
Codechinus.
Cottaldia.
Stomechinus.
Hypechinus.

1855.

WRIGHT, Brit. Oolitic Echin., 1855, p. 145.

Hemipedina.

1855.

MICHELIN, Rev. Mag. Zool. 1855, p. 245, *Mai.*

Moera (**Mich.**) non LEACH, 1813 nec HUBN. 1816.
atropos
lachesis.
clotho!

1855.

COTTEAU, Échin. Yonne. I. 1855, p. 224.

Desoria (**Cott.**) non AGASS.

1855.

COTTEAU, Bull. Soc. Géol. France, XII., 1855, p. 710, *Mai.*

Desorella.

1856.

COTTEAU, Bull. Soc. Géol. France, XIII., 1856, p. 319, *February.*

Micropsis.
Cyclaster.

1856.

CONRAD, Pacif. R. R. Ex. Pal. VII. 1856, p. 196, *Pl. IX.*

Asterodaspis.
Scutella
striatula non M. de SERRES = *Scutella* **excentrica** ESCH. 1829.

1856.

COTTEAU, Échin. Sarthe, 1856, p. 417.

Galeropygus.

* No species mentioned, group specified.

1856.

DESOR, Synops. Échin. foss. 1856, pp. 131 – 155.

Stirechinus.
Phymechinus.
Diplophorus (err. typ.) **Diploporus** TROSCH. Ms.
Sphaerechinus
 brevispinosus.
Loxechinus
 albus.
Hyposalenia.
Eocidaris.

1856.

D'ORBIGNY, Pal. franç. Crét. VI. 1856, p 418.

Clypeopygus.

1856.

MÜLLER, J., Echin. Eifel. Kalk. Berl. Ak. 1856, p. 356.

Lepidocentrus.

1856.

HUPÉ, in Castelnau Voyage Am. Sud. 1856.

Echinus
 aciculatus ! = *Echinus* **Gaimardi** BLAINV. 1825.
Heliocidaris
 Castelnaudi ! = *Echinus* **lucunter** LIN. 1758.
Echinoglycus
 Valenciennesii.
 oblongus.
 subclausus.

1857.

BARRETT, Ann. Mag. Nat. Hist. XIX. 1857, p. 32, *January.*

Amphidotus
 gibbosus (**Barrett**) non AG. = *Echinocardium* **pennatifidum** NORM. 1869.

1857.

STIMPSON, Crust. Ech. Pacif. Sh., Journ. Bost. Soc. N. H. 1857.

Echinus
 chloroticus ! non VAL. 1846 (err. typ.) *chlorocentrotus* BR.
 purpuratus !

1857.

MCCRADY, in Tuomey and Holmes Pliocene foss. So. Ca. pp. 4 – 10, 1857.

Psammechinus
 exoletus = *Echinus variegatus* (**Lam.**) 1816, non LESKE.
Agassizia
 porifera.
Amphidetus
 ampliflorus = *Echinus* **cordatus** PENN. 1777.
 orthonotus.
Brissus
 spatiosus = *Spatangus* **ventricosus** LAM. 1816.
Plagionotus
 Holmesii = *Echinus* **grandis** GMEL. 1788.
 Ravenellianus = " " " "

1857.

GRUBE, Wieg. Archiv. I. 1857.

Brissus

panis ! = *Spatangus* **ventricosus** LAM. 1816.

1857.

D'ORBIGNY, Pal. franç. Crét. VI. 1857, p. 454.

Oolopygus.

1857.

DESOR, Synops. Échin. foss. 1857, pp. 167–333.

Pileus.
Galeopyyus (err. typ.) **Galeropygus** COTT. 1856.
Pachyclypus.
Sismondia.
Rumphia
rostrata.
Peronii.
Mortonia (**Des.**) non GRAY. 1851.
Stenonia
Offaster.

1857.

SALTER, Ann. Mag. N. H. 1857, p. 332, *November.*

Paleodiscus.

1857.

PHILIPPI, Wieg. Arch. I. 1857.

Echinus

magellanicus.

Arbacia

Schythei = *Echinocidaris* **Dufresnii** BLAINV. 1825.

1858.

COTTEAU, Rev. Mag. Zoöl. 1858, *Mai.*

Pseudopedina.

1858.

EBRAY, Bull. Soc. Géol. Franc. XV. 1858, p. 482.

Centropygus.

1858.

DESOR, Synops. Échin. foss. 1858, pp. 359–416.

Isaster.
Toxobrissus.
Hemipatagus.

1858.

QUENSTEDT, Der Jura, 1858, p. 644, *Pl. II.*

Polycidaris.
Leptocidaris.

1858.

MICHELIN, Rev. Mag. Zoöl. 1858, *August.*

Mellita
longifissa !

1859.

COTTEAU, Rev. Mag. Zoöl. 1859, pp. 14 – 22, *April.*

Asterocidaris.
Pseudosalenia.

1859.

MICHELIN, 1859.

Hebertia.*

1859.

BRONN, Die Kl. u. Ord. d. Thier-Reichs, 1859, p. 341.

Schizaster
cordatus.

1859.

COTTEAU, Échin. Sarthe, 1859, pp. 210, 429.

Anorthopygus.

1859.

MICHELIN, Rev. Mag. Zoöl. 1859, *September.*

Echinarachnius
asiaticus ! = *Scutella* **Rumphii** BLAINV. 1827.
Australiae ! = " " " "
undulatus ! = " " " "
Polyaster non GRAY, 1840.
elegans ! = *Lagana* **decagona** LESS. 1841.

1860.

COTTEAU, Bull. Soc. Géol. Franc. XVII. 1860, p. 378, *Mars.*

Heterocidaris.

1860.

ÉTALLON, Rayonn. du Jura Sup. de Montbéliard. 1860.

Pseudodesorella.

1860.

L. AGASSIZ, Proc. B. S. N. H. 1860, p. 262, *Mai.*

Pygorhynchus
sp. !

1860.

COTTEAU, Échin. Sarthe, 1860.

Echinocyphus.

* Know this from COTTEAU's quotation only.

1860.

MAYER, Faunula d. Mar. Sandst. 1860, p. 11, *August.*

Leiospatangus.

1860.

COTTEAU, Échin. Yonne, II. 1860, p. 83.

Phyllobrissus.

1860.

MEEK & WORTHEN, Proc. A. N. S. Phila. 1860, pp. 396, 472.

Melonechinus
Oligoporus.

1860.

HOLMES, Post Plio. foss. So. Ca. 1860, p. 5, *Pl. II. f. 2.*

Anapesus
carolinus ! = *Echinus* **punctulatus** LAM. 1816.

1861.

THOMSON, Edinb. New Phil. Jour. 1861, *January.*

Echinocystites.

1861.

COTTEAU, Pal. franç. Crét. VII. 1861, p. 96, *July.*

Heterosalenia.

1861.

MICHELIN, Rev. Mag. Zoöl. 1861, *July.*

Lobophora
Deplanchei ! = **Mellita laevis** KLEIN, 1734.
Clypeaster
Saisseti ! = *Echinanthus* **humile** LESKE. 1778.

1861.

COTTEAU, Échin. Sarthe, 1861, p. 403.

Leiosoma.

1861.

HALL, Prel. Notice new sp. Crinoids, 1861, p. 18.

Lepidechinus.

1861.

SARS, Norges Echin. 1861, p. 96, *June.*

Tripylus
fragilis !

1862.

COTTEAU, Rev. Mag. Zoöl. 1862, p. 72, *Mai.*

Heterolampas.
Heterodiadema.
Orthocidaris non A. AG. 1863.

1862.
ÉTALLON, Études paléont. s. le terr. Jurass. Haut Jura; Suppl. 1862, pp. 4, 5.

Pseudocidaris.
Hemipygus.

1862.
DUJARDIN et HUPÉ, Zooph. Échinodermes, 1862.

Leiocidaris
hystrix !
papillata !
affinis !
Stokesi !
Thouarsii !
Danae !
Salmacis
Desmoulinsii (err. typ.) **Dussumieri** AGASS.
Melebosis (err. typ.) **Melobosis** GIR. 1850.
mirabilis.
Psammechinus
pulchellus !
pustulatus !
decoratus !
longispinus !
laganoides !
magellanicus !
aciculatus !
Sphaerechinus
esculentus !
gibbosus !
Toxopneustes
aequituberculatus !
Tripneustes
fasciatus !
angulosus !
Michelinia non KONINCK, 1842.
elegans !
Podophora
Mertensii
Brissopsis
excavatus !
Philippii !
Echinolampas
ovatus !

1862.
MICHELIN, in Maillard, notes s. Bourbon, Annéxe A. 1862.

Keraiaphorus
Maillardi !
Savignya
Frappieri ! = *Astropyga* **Desorii** AG. 1846.
Tripneustes
fuscus ! = *Cidaris* **sardica** LESKE, 1778.
zigzag ! = " " " "

1862. MICHELIN (*continued*).

Toxopneustes
indianus !
Hemipatagus
Mascareignarum ! = *Spatangus* **planulatus** LAM. 1816.

1863. COTTEAU, Échin. foss. des Pyren. 1863.

Pedinopsis.
Brissopatagus.

1863. BELVAL, Bull. Acad. Brux. XV. 1863, p. 419, *March.*

Encope
Ghiesbrechtii = *Echinodiscus* **emarginatus** LESKE, 1778.

1863. COTTEAU, Pal. Franç. Crét. VII. 1863, *April.*

Temnocidaris.

1863. COTTEAU, Échin. Sarthe, 1863, p. 399.

Orthopsis.

1863. COTTEAU, Rev. Mag. Zoöl. 1863, p. 77, *June.*

Microdiadema.

1863. A. AGASSIZ, Bull. Mus. Comp. Zoöl. I. 1863, *August.*

Gymnocidaris
metularia !
minor ! = *Cidarites* **metularia** LAM. 1816.
Orthocidaris (**A. Ag.**) non COTT. 1862.
hystrix !
affinis !
papillata !
Temnocidaris (**A. Ag.**) non COTT. 1863.
canaliculata !
Prionocidaris
pistillaris !
Stephanocidaris
tubaria ! non LAM. = *Cidarites* **bispinosa** LAM. 1816.
Chondrocidaris
gigantea !
Garelia
subularis !
cincta ! = **Diadema turcarum** SCHYNV. 1711.
turcarum !
Echinothrix
aperta ! = *Echinus* **calamaris** PALL. 1774.
scutata ! = *Astropyga* **Desorii** AG. 1846.

1863. A. AGASSIZ (*continued*).

Diadema
paucispinum ! = *Diadema setosa* (**Gray**,) 1825.
mexicanum !
globulosum ! = *Diadema setosa* (**Gray**,) 1825.

Echinocidaris
Davisii ! = *Echinus* **punctulatus** LAM. 1816.
incisa ! = *Echinus stellatus* BLAINV. 1825.

Echinostrephus
aciculatus ! = *Echinometra* **setosa** RUMPH. 1705.

Acrocladia
cuspidata ! = *Echinus* **trigonarius** LAM. 1816.

Podophora
Quoyi !

Echinometra
Van Brunti !
rupicola ! = *Echinometra* **Van Brunti** A. AG. 1863.
microtuberculata ! = *Echinus lucunter* (**Lam.**) non LINN.
viridis !
plana ! = *Echinometra* **viridis** A. AG. 1863.

Parasalenia
gratiosa !

Toxocidaris
Delalandi !
mexicana ! (**A. Ag.**) non AG.
franciscana !

Loxechinus
purpuratus !

Psammechinus
chloroticus !

Sphaerechinus
granularis !

Temnopleurus
Reevesii ! non GRAY = **Cidaris toreumatica** KLEIN, 1734.

Toreumatica
concava ! non GRAY = *Temnopleurus* **Reynaudi** AG. 1846.

Melobosis
rarispinus !

Lytechinus
carolinus ! = *Echinus variegatus* (**Lam.**) non LESKE.
variegatus !
atlanticus ! = " " " "

Hemiechinus GIR. MS.

Boletia
granulata !
rosea !

Tripneustes
depressus !

Hipponoe
violacea ! = *Cidaris* **sardica** LESKE, 1778.
nigricans ! = " " " "

1863. A Agassiz (*continued*).

Stolonoclypus Agass.

placunarius !

prostratus !

rotundus !

Rhaphidoclypus

scutiformis !

microtuberculatus ! = *Echinus* **reticulatus** Lin. 1758.

Rumphia

Lesueuri !

Pygorhynchus

pacificus ! Agass.

Kleinia

nigra ! = **Meoma grandis** Gray, 1851.

Rhyssobrissus

niger !

Xanthobrissus.

Garetti ! = *Spatangus* **sternalis** Lam. 1816.

1863.

S. P. Woodward, Geologist, 1863, *September.*

Echinothuria.

1863.

A. Agassiz, Proc. Acad. Nat. Scien. Phila. 1863, *December.*

Phyllacanthus

fustigera ! Barn. = *Cidarites* **imperialis** Lam. 1816.

Diadema

nudum ! = *Diadema setosa* (**Gray**,) 1825.

Thrichodiadema

Rodgersii !

Colobocentrotus

Leskei ! (err. typ.) *Mertensii.*

Echinometra

brunea ! = *Echinus lucunter* (**Lam.**) non Linn.

Glyptocidaris

crenularis !

Toxocidaris

nuda !

crassispina ! = *Echinus* **tuberculatus** Lam. 1816.

globulosa ! = **Toxocidaris franciscana** A. Ag. 1862.

depressa !

Psammechinus

intermedius ! Barn.

pulcherrimus ! Barn.

Toxopneustes

carnosus ! Barn. = *Echinus* **Dröbachiensis** Müll. 1776.

Microcyphus

elegans ! = **Toreumatica Hardwickii** Gray, 1855.

Anthechinus

roseus ! = *Microcyphus* **maculatus** Ag. 1841.

1863. A. Agassiz (*continued*).

Temnotrema
sculpta ! = **Toreumatica Hardwickii** Gray, 1855.
Laganum
Putnami ! Barn.
Scaphechinus ! Barn.
mirabilis ! Barn.
Lobophora
texta ! = **Mellita laevis** Klein, 1734.
Maretia
alta !
Lovenia
triangularis ! = *Spatangus* **subcarinatus** Gray, 1845.
Echinocardium
Stimpsoni ! = *Echinocardium* **australe** Gray, 1851.

1863.
Belval, Bull. Acad. Brux. XVI. 1863, p. 198, *August*.

Lobophora
Dubusii = *Echinodiscus* **auritus** Leske, 1778.
Agassizii = " " " "

1864.
Lütken, Bid. til Kunds. om Echin. 1864.

Psilechinus
variegatus !
Meoma
ventricosa !
Echinocidaris
longispina ! = *Echinus* **stellatus** Blainv. 1825.
Clypeaster
Riisei ! = **Stolonoclypus rotundus** A. Ag. 1863.
Agassizia
ovulum ! = **Agassizia scrobiculata** Val. 1846.
Goniocidaris
tubaria !
Anthocidaris
homalostoma !
eurythrogramma !
Ellipsechinus
macrostomus !
Echinometra
Michelini ! non Des.
arbacia ! = **Parasalenia gratiosa** A. Ag. 1863.
Psammechinus
verruculatus ! = *Cidaris* **angulosa** Leske, 1778.
Ravenellia
Chaetodiscus
scutella ! = **Scaphechinus mirabilis** Barn. 1863.

1864. Lütken (*continued*).

Rhynchopygus
caribaearum !
Sphaeriechinus (err. typ.) **Sphaerechinus** Des. 1856.
granularis
indianus !
Brissopsis
pulvinatus

1865. Conrad, T. A., Proc. Acad. N. S. Phila. 1865, p. 74.

Macrophora
Echinianthus (err. typ.) **Echinanthus** Breyn. 1732.
Echinocardium
orthonotus.

1865. Martens, Monatsb. Ak. Berlin, 1865, *März*.

Scutella
japonica ! = **Scaphechinus mirabilis** Barn. 1863.
Nucleolites
epigonus !

1865. Bölsche, Wieg. Archiv. I. 1865, p. 324.

Echinothrix
cincta !
aequalis !
clavata !
Petersii ! = **Diadema turcarum** Schynv. 1711.
Astropyga
major = *Cidarites* **radiata** Leske, 1778.

1865. Grube, Jahres-Ber. d. Schles. Ges. 1865.

Platybrissus
Roemeri !

1866. Worthen & Meek, Paleontology, Geology of Illinois, Vol. II. 1866, p. 249.

Melonopsis.

1866. Cotteau, Pal. franç. VII. Terr. Crét. 1866, p. 760, *Mai*.

Leiocyphus

1866. Gray, Proc. Zoöl. Soc. London, 1866, p. 170, *June*.

Spatangus
Maretia
variegata ! = *Spatangus* **planulatus** Lam. 1816.

1866.
COTTEAU, Rev. Mag. Zoöl. 1866, *Juin, Juillet.*

Leiopedina.
Echinopedina.

1866.
VERRILL, Proc. Bost. Soc. N. H. 1866 p. 340, *July.*

Euryechinus
granulatus !
Dröbachiensis !
lividus
gibbus ! (err. typ.) *Echinus* **gibbosus** VAL. 1846.
Delalandii

1866.
MARTENS, Wieg. Archiv. XXXII. 1866.

Temnopleurus
japonicus ! = *Temnopleurus* **Hardwickii** GRAY, 1855.
Echinus
disjunctus ! = *Toxocidaris* **depressa** A. AG. 1863.
Boletia
radiata ! = *Psammechinus* **pulcherrimus** BARN. in A. AG. 1863.
polizonalis.
Toxocidaris
purpurea ! = *Echinus* **tuberculatus** LAM. 1816.
Cidaris
circinnata MS. Amsterd. Mus. = *Cidarites* **annulifera** LAM. 1816.
fustigera !
Diadema
calamare !
Salmacis
pyramidata !
conica ! = *Salmacis* **sulcatus** AG. 1846.
Clypeaster
testudinarius !
Nucleolus ! (err. typ.) **Nucleolites** LAM. 1801.
epigonus !

1866.
MARTENS, Verhl. d. K. K. Zool. Bot. Ges. Wien, 1866, p. 381.

Acrocladia
planissima ! = **Cidaris mammillata** KLEIN, 1734.

1866.
SCHULTZE, L., Echinod. d. Eifler Kalkes. Denk. schr. Wien. Akad., 1866.

Xenocidaris.

1867.
COTTEAU, Pal. franç. VII. Terr. Crét. 1867, p. 822, *January.*

Micropedina.

1867.
GRUBE, Jahresb. d. Schles. Ges. f. Vat. Cult. 1867, *April.*

Asthenosoma
varium !

1867. GRUBE (*continued*).

Salmacis
rubrotinctus ! = *Salmacis* **rarispinus** AG. 1846.
festivus ! = " " " "

1867.
VERRILL, Notes on Radiata, Trans. Conn. Acad. 1867; in Reprint, *June*.

Echinodiadema
coronata !
Astropyga
venusta ! = *Cidarites* **pulvinata** LAM. 1816.
Psammechinus
pictus ! = *Echinus* **semituberculatus** VAL. 1847.
Lytechinus
roseus !
Boletia
viridis ! = *Echinus* **chloroticus** VAL. 1846.
Euryechinus
imbecillis ! = *Echinus* **gibbosus** VAL. 1846.
Toxopneustes
sp. ! = **Toxocidaris** *mexicana* (**A. Ag.**) 1863.
Encope
occidentalis ! = *Encope* **micropora** AG. 1841.
Astriclypeus
Manni !
Mellita
pacifica !
Stoloniclypeus (err. typ.) **Stolonoclypus** AG. 1863.
rotundus !
Brissus
obesus !
Meoma
nigra !
Metalia
nobilis ! = *Echinus* **maculosus** GMEL. 1788.
Garetti !

1867.
MARTENS, Wieg. Arch. XXXIII. 1867, p. 112.
Encope
aberrans ! = *Encope* **Michelini** AG. 1841.

1867.
LOVEN, Öfv. K. Vet. Akad. Förh. 1867.
Palaeostoma
mirabilis !

1868.
NORMAN, 4th Dredging Report Shetland Islands, Brit. Ass. Adv. Sci. 1868, p. 314.
Toxopneustes
pictus ! = *Echinus* **Dröbachiensis** MÜLL. 1776.

1868. NORMAN (*continued*).

Echinocardium
pennatifidum.
Spatangus
meridionalis ! (**Norm.**) et auct. anglic. non RISSO = *Spatangus* **Raschi** LOVEN, 1869.

1868. LAUBE, Echin. d. Vicentin. Tertiärgebiets, Akad. Wien. p. 13, 1868.

Chrysomelon.

1868. TROSCHEL, Nieder Hess. Gesell. f. Nat. u. Heilkun. 1868, *July*.

Crustulum
gratulans ! = **Astriclypeus Manni** VERRILL, 1867.

1868. WORTHEN & MEEK, Geol. Pal. Illinois, III. 1868, p. 522.

Lepidesthes.

1868. GRUBE, Monatsb. Berlin, Ak. 1868, *März*.

Anochanus
sinensis !

1869. VERRILL, Proc. Bost. Soc. N. H. 1869, *April*.

Desoria
nodosa ! = *Desoria* **australis** GRAY, 1851.

1869. COTTEAU, Rev. Mag. Zoöl. 1869, *Mai*.

Echinodiadema (**Cott.**) non VERRILL, 1867.

1869. LOVEN, Öfv. af. K. Vetensk. Ak. Förh. 1869.

Spatangus
Raschi !

1869. THOMSON, Dredging Rept. Porcupine, Proc. R. S. 1869.

Calveria
hystrix !

1869. TROSCHEL, Verhandl. N. H. V. Rhein. u. West. 1869, p. 96.

Pseudoboletia
maculata ! = *Toxopneustes* **indianus** MICH. 1862.
stenostoma ! = *Boletia* **granulata** A. AG. 1863.
Podophora
quadriseriata = **Colobocentrotus Mertensii** BR. 1835.

1869.

E. v. MARTENS, Decken's Reise in Ost. Africa, Seesterne u. Seeig. v. Sancibar, 1869.

Bryssus (err. typ.) **Brissus** KLEIN, 1734.
sternalis.
bicinctus.
carinatus.
compressus.

1869.

A. AGASSIZ, Prelim. Report Echini. Bull. M. C. Z. II. 1869, p. 9, *October.*

Cidaris
annulata ! non GRAY, = *Cidarites* **tribuloides** LAM. 1816.
Dorocidaris
abyssicola ! = *Cidaris* **papillata** LESKE, 1778.
hystrix !
papillata !
affinis !
Stokesii !
Salenocidaris
varispina !
Caenopedina
cubensis !
Podocidaris
sculpta !
Echinus
gracilis !
Flemingii ! non BALL. = *Echinus* **norvegicus** D. o. K. 1844.
Genocidaris
maculata !
Trigonocidaris
albida !
Stolonoclypus
Ravenellii !
Encope
Griesbachii (err. typ.) *Ghiesbrechtii.*
Echinolampas
caratomoides ! = *Echinolampas* **depressus** GRAY, 1851.
Rhyncholampas
caribbaearum !
pacificus !
Neolampas
rostellatus !
Pourtalesia
miranda !
Lissonotus (**A. Ag.**) non SCHÖN. 1817.
fragilis !
Agassizia
excentrica !
Echinocardium
laevigaster ! = *Echinocardium* **pennatifidum** NORM. 1868.
Kurtzii !

1869. A. AGASSIZ (*continued*).

Schizaster
cubensis ! non d'ORB. in AG. C. R. = *Brissus* **fragilis** D. o. K. 1844.
Diadema
mexicanum ! juv. non A. AG. = **Echinodiadema coronata** VERRILL. 1867.
Lytechinus
semituberculatus !
Plagionotus
nobilis !

1869.

PERRIER, Pédicell. Thèse Fac. Scienc. Paris, 1869.

Cidaris
rosaceus ! ROUSSEAU = *Cidarites* **annulifera** LAM. 1816.
Callao ! = *Cidaris* **Danae** AG. 1846.
Echinus
lezaroides ! (err. typ.) *laganoides* = *Echinus* **molaris** BLAINV.
Psammechinus
No. 248 ! = *Echinus variegatus* (**Lam.**) 1816, non LESKE.
Tripneustes
bicolor ! VAL. = *Cidaris* **sardica** KLEIN, 1734.
Echinometra
No. 274 ! = *Echinus* **purpuratus** STIMPS. 1857.
Acrocladia
violacea ! BLAINV. = *Echinus* **trigonarius** LAM. 1816.
serialis ! VAL. = **Cidaris mammillata** KLEIN, 1734.
Echinolampas
cyclostomus ! = **Scutum ovatum** KLEIN, 1734.
Hellei ! VAL. = *Echinolampas Richardi* (**Desml.**) 1837, non DESMT.
Brissopsis
parma ! VAL. = *Brissus* **lyrifer** FORBES, 1841.
No. 18 ! = " " " "
Breynia
nigra !
Amphidetus
Novae Zelandiae ! VAL. = *Echinocardium* **australe** GRAY, 1851.
No. 71 ! = *Echinus* **cordatus** PENN. 1777.
No. 193 ! = **Spatagus flavescens** MULL. 1774.
Gaimardi ! = ?
Lovenia
quadrimaculata ! VAL. = *Spatangus* **planulatus** LAM. 1816.

1869.

POMEL, Introduc. aux Échinodermes, 1869.

Trachypatagus.
Leiopatagus (err. typ.) **Leiospatangus** MEYER, 1860.
depressus.
hypsopatagus.

1869. POMEL (*continued*).

hemibrissus
ventricosus.
Schizobrissus.
peribrissus.
trachyaster.
paraster
gibberulus.
bolbaster.
hypsaster.
heteropneustes.
hypsoclypus.
clypeolampas.
Echinolampas
Bottae ! = **Scutum ovatum** KLEIN, 1734.
amphisalenia.
prodiadema.
glyphopneustes.
malebosis (err. typ.) **Melobosis** GIR. 1850.
micropsidia.
arbacina.
schizechinus
semitubercutatus.
variegatus
excavatus.
oligophyma.
Olopneustes (err. typ.) **Holopneustes** AG. 1841.
MacCoya.
Wrightia (**Pomel**) non AGASS. 1862.

1870.

G. O. SARS, Nye Echin. Vid. Selsk. Forh. 1871.

Echinus
depressus non BLAINV.
Toxopneustes
pallidus = *Echinus* **Dröbachiensis** MULL. 1776.

1870.

VERRILL, Sill. Journ. 1870, p. 93, *January.*

Clypeaster
speciosus ! = *Echinanthus* **testudinarius** GRAY, 1851.
Encope
californica !

1870.

DESMOULINS, Act. Soc. Linn. Bordeaux, 1870.

Echinolampas
Rangii = *Echinolampas* **Hellei** VAL. in PERR. 1869.

1871.

VERRILL, Notes on Radiata, Trans. Conn. Acad. 1871, *February* and *March.*

Plagionotus
africanus !
Boletia
picta !
Evechinus
chloroticus !
Toxocidaris
homalostoma !
eurythrogramma !
Clypeaster
testudinarius ! = *Echinanthus* **testudinarius** GRAY, 1851.

1871.

A. AGASSIZ, Bull. M. C. Z. No. 5, II. 1871, *April;* Suppl. to Bull. No. 9, I. 1869.

Coelopleurus
Maillardi !
sp.

1871.

COSTA, O. G., Monog. degli Echinocyami viv e foss.......1871.

Echinocyamus
parthenopaeus = **Spatagus pusillus** MÜLL. 1776.
speciosus = " " " "

1872.

A. AGASSIZ, Preliminary Notice of a few Echini, Bull. M. C. Z. III. No. 4, 1872, *January.*

Strongylocentrotus
armiger !
Sphaerechinus
Australiae !
Amblypneustes
pentagonus !
inflatus ! LÜTK.
purpurescens ! LÜTK.
Holopneustes
inflatus !
purpurescens !
Spatangus
Lütkeni !
Lovenia !
cordiformis ! LÜTK.
Moera
stygia ! LÜTK.
Rhynobrissus
pyramidalis !

SYNONYMY.

THIS second series of lists contains the Synonymy, which I look upon as the *history of the species* (not its Natural History). The synonymes quoted have all been taken from the originals unless otherwise marked (teste . . . . . .), giving the authority for their accuracy. The (!) therefore does not mean that I have verified the quotation, but that I have examined authentic specimens. The genera adopted in this revision, as well as the species in their respective genera, are arranged alphabetically. In the descriptive part of the text the references for the name adopted and for the original name alone are given; the notation is as follows: —

Temnopleurus toreumaticus
Cidaris toreumatica! KLEIN, 1734, Nat. Disp. Ech.
Temnopleurus *toreumaticus*! AGASS. 1841, Monog. Scut.

Amblypneustes griseus
Echinus **griseus**! LAM. 1816, An. s. Vert.
Amblypneustes *griseus*! AGASS. 1841, Monog. Scut.

the character of the type, of the original name, always showing the relations of the specific and generic names at the time the species was described, as in the Chronological List. Not to introduce too many doubtful synonymes, a general concordance of all the names given to Echini, including MS. names mentioned, is added, where doubtful synonymes will be found recorded by referring them to some species of this Revision; this may serve as a ready reference for all the known species. To supplement the Chronological, Synonymic, and Alphabetical Lists, I shall add a Systematic Index of the species, mentioned in this Revision, giving the original name and the principal localities. As it was found impossible to add to each citation a locality without introducing too much doubtful material, only accurate localities are quoted. For each species I have given a complete list of all the localities from which specimens are recorded, with their authorities, indicating at the same time by the usual mark (!) whenever I have seen the specimens mentioned. In the Geographical Lists the species found in any one locality will be so arranged as to show the faunal peculiarity of a region, while the exact range of each species is always carefully specified with its synonymy. (*) denotes that specimens are in the Coll. M. C. Z.

AGASSIZIA.

Agassizia VAL. 1846. Voyage Vénus.
Agassizia AGASS. 1847. Cat. Rais. Ann. Sc. Nat., VIII. p. 20.

Agassizia excentrica

Agassizia **excentrica** ! A. AGASS. 1869. Bull. M. C. Z., I. p. 276. Straits of Florida.
? *Brissopsis* **poriferus** RAV. 1848. Echin. So. Ca.
? *Agassizia porifera* McCRADY, 1851. In Plioc. Foss. So. Ca., *Pl. I. f. 5.*

*Off Tortugas, 35, 36 fms. 45 fms. ! *Florida Gulf Stream ! (Pourtalès).

Agassizia scrobiculata

Agassizia scrobiculata ! VAL. 1846. Voyage Vénus, Zooph., *Pl. I. f. 2.* Peru.
Agassizia scrobiculata ! VAL. 1847. In Agass. C. R. Ann. Sc. Nat., VIII. p. 20.
" " GRAY, 1855. Cat. Recent Echini, p. 62.
" " ! DUJ. HUPÉ, 1862. Échin, p. 604.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 28. Panama.
" " ! PERRIER, 1869. Pédicell., p. 177.
Agassizia **subrotunda** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 133.
" " ! " 1855. Cat. Rec. Ech., p. 63., *Pl. III. f. 2.* Australia?
" " ! VERRILL, 1870. Sill. Journ., XLIX. p. 95.
" " ! " 1869. Proc. Bost. S. N. H., p. 382.
" " ! " 1871. Notes on Radiata, p. 593.
Agassizia **ovulum** ! LÜTK. 1864. Bidrag...... p. 134, *Pl. II. f. 8.* Boccones.
" " ! VERRILL, 1867. Notes on Radiata, p. 320. Panama.

*Panama (A. Agassiz, Jewett) ; *Peru (J. d. P.) ; Boccones ! (Mus. Cop) ; La Paz ! (Pedersen, Yale Coll.).

AMBLYPNEUSTES.

Echinus LAMK. 1816. A. s. V. (pars.)
Amblypneustes AGASS. 1841. Introd. Monog. Scut.
Amblypneustes AGASS. 1846. C. R. Ann. Sc. Nat., VII. p. 362.
Codechinus DES. 1855. Synops. Éch. foss.

Amblypneustes formosus

Amblypneustes **formosus** ! VAL. 1846. Voyage Vénus, Zooph., *Pl. II. f. 2.*
" *formosus* ! DUJ. HUPÉ, 1862. Échin, p. 518.
" **scalaris** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 362. New Holland.
" *scalaris* ! DUJ. HUPÉ, 1862. Échin., p. 518.

? Galapagos ! (J. d. P.) ; *Australia ; Tasmania ! Adelaide ! (Brit. Mus.).

Amblypneustes griseus

Echinus **griseus** ! Blainv. 1825. Dict. S. N. Oursin, p. 81.
Echinus griseus ! Blainv. 1834. Actinol., p. 227.
" " ! Desml. 1837. Syn., p 274.
Amblypneustes *griseus* ! Agass. 1841. Monog Scut. Introd.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 362. Vanikoro.
Amblypneustes griseus ! Duj. Hupé, 1862. Échin., p. 518.

*Australia ! *New Zealand ! (Wright) ; Port Jackson ! (Mus. Stutt.) ; Vanikoro ! (J. d. P.) ; Adelaide ! Van Diemen's Land ! Port Philip ! Murray Riv. ! New Zealand ! (Brit. Mus.)

Amblypneustes ovum

Echinus **ovum** ! Lamk. 1816. An. s. Vert., p. 48. Australia ?
Echinus ovum ! Blainv. 1825. Dict. S. N. Oursin, p. 81.
" " ! Blainv. 1834. Actinol., p. 227.
" " Desml. 1837. Syn., p. 274.
Amblypneustes ovum Agass. 1841. Int. Anat. Ech., p. ix.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 362.
" " ! Duj. Hupé, 1862. Échin., p. 517.
" **textilis** ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 362.
" *textilis* ! Duj. Hupé, 1862. Échin., p. 518.
" **serialis** ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 362.
" *serialis* ! Duj. Hupé, 1862. Échin., p. 518.

*Australia ! *Hobart Town ! (Hamb'g Mus.) ; *Van Diemen's Land ! (B. M. Wright) ; Port Jackson ! (Mus. Stutt.) ; Port Lincoln ! Port Philip ! Tasmania ! (Brit. Mus.).

Amblypneustes pallidus

Echinus **pallidus** ! Lamk, 1816. An. s. Vert., p. 48.
" *pallidus* DesLong. 1824. Enc. Méth., II. p. 591.
" " ! Blainv. 1825. Dict. S. N. Oursin, p. 81.
" " ! Blainv. 1834. Actinol., p. 227.
" " Desml. 1837. Syn., p. 274.
" (*Amblypneustes*) *pallidus* ! Val. 1846. Voyage Vénus, Zooph., *Pl. II. f. 1.*
Amblypneustes pallidus ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 362 Australia.
" " ! Duj. Hupé, 1862. Échin., p. 518.

*M. C. Z. ; Port Jackson ! (Mus. Stutt.) ; Holdfast Bay ! Murray Riv. ! Port Philip ! Adelaide ! Feejee Islands ! (Brit. Mus.) ; Vanikoro ! (J. d. P.).

Amblypneustes pentagonus

Amblypneustes **pentagonus** ! A. Ag. 1872, Bull. M. C. Z., III. No. 5. Mauritius ?

*Mauritius (Brandt).

† (ECHINOBRISSUS.) Anochanus.

Anochanus Grube, 1868. Monatsb. d. Akad. Berlin, March, p. 178.

Anochanus sinensis

Anochanus sinensis ! Grube, 1868. Monatsb. d. Ak. Berlin, March, p. 178. China Seas.

East India Islands ! (Grube, Breslau Mus.).

† When a genus appears in parentheses its subgenera are denoted by smaller type, — Anochanus.

ARACHNOIDES.

Echinodiscus BREYN. 1732. Schedias. (pars.)
Arachnoides KLEIN, 1734. Nat. Disp. Ech.
Echinus LIN. 1758. Syst. Nat. (pars.)
Echinarachnius LESKE, 1778. KL. Add. (non GRAY, nec AGASS.)
Scutella LAMK. 1816. An. s. Vert. (pars.)
Echinodiscus BLAINV. 1830. Actinol. (pars.)
Arachnoides AGASS. 1841. Monog. Scut., p. 94.

Arachnoides placenta

...... RUMPH. 1705. Amb. Rar. Kam., *Pl. XIV. f.* G.
Echinodiscus *maximus* ...... BREYN. 1732. Schedias., p. 64, *Pl. VII. f. 7, 8.*
Arachnoides KLEIN, 1734. Nat. Disp. Ech., *Pl. XX. f.* A, B.
...... GUALTERI, 1742. Index Test., *Pl. CX. f.* G.
...... SEBA, 1758. Thes., III. *Pl. XV. f. 21, 22.*
Echinus **placenta** LINN. 1758. Syst. N., ed. X. p. 666.
" *placenta* GMEL. 1788. LINN. Syst., 3195.
Scutella " ! LAMK. 1816. An. s. Vert., p. 11. So. Pacific.
Scutella " ! BLAINV. 1827. Dict. S. N. Scut., p. 225.
" " DESML. 1837. Syn., p. 228.
Echinarachinus *placenta* ! LESKE, 1778. KL. Add., *Pl. XX. f.* A, B.
Echinarachnius placenta ! GRAY, 1825. Ann. Phil., p. 6.
" " FLEM. 1828. Brit. An., p. 479.
" " ! AGASS. 1836. Prod., p 188.
" " FORBES, 1841. Brit. Starf., p. 178. Shetland?
" " ! GRAY, 1848. Brit. Rad., p. 5.
Echinodiscus " ! BLAINV. 1834. Actinol., p 64, *Pl. VII. f. 7, 8.*
Arachnoides " ! AGASS. 1841. Mon. Scut., p. 94, *Pl. XXI. f. 35–42.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 134. Amboina, Salomon Isl.
" " MÜLL. 1854. Bau d. Ech., *Pl. IV. f. 6, 7.*
" " ! GRAY, 1855. Cat. Rec. Ech., p. 13. Australia.
" " BRONN. 1859. Kl. u. Or. Actin., *Pl. XXXIX. f. 2.*
" " DUJ. HUPÉ, 1862. Échin., p. 561.
Echinarachnius **Zelandiae** ! GRAY, 1845. Deiffb. Voy., II. p. 265. New Zealand.
Arachnoides Zelandiae ! GRAY, 1855. Cat. Rec. Ech., p. 14, *Pl. II. f. 2.*

***Auckland, *New Zealand (Edwards); *Port Mackay (Mus. Godef.); *Singapore (Novarra Ex.) *Cape York (Salmin); Amboina! Salomon Islands! (J. d. P.); Flinder's Island! Torres Straits! Cape Upstart! (Brit. Mus.); Burmah! (Boston N. H. Soc.); Philippine Islands! (Semper); Luzon! (Mus. Berl.); Timor, Buru, Borneo, New Holland (Martens).**

ARBACIA.

Cidaris LESKE, 1778. KL. Addit. (pars.)
Echinus LAMK. 1816. An. s. Vert. (pars.)
Arbacia GRAY 1835. Proc. Zoöl. Soc. Lond., p. 58, April (non AGASS.).
Echinocidaris DESML. 1835. Tabl. Syn. July.
Agarites AGASS. 1841. Introd. Mon. Scut.
Tetrapygus AGASS. 1841. Introd. Mon. Scut.
Agarites AGASS. 1846. C. R. Ann. Sc. Nat., VI.
Tetrapygus AGASS. 1846. C. R. Ann. Sc. Nat., VI.

Arbacia Dufresnii

Echinus **Dufresnii** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 76.
" *Dufresnii* ! BLAINV. 1834. Actinol., p. 226.
Arbacia " ! GRAY, 1835. Proc. Zoöl. Soc. Lond., p. 38.
Echinocidaris Dufresnii DESML. 1837. Syn., p. 306.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353.
" " ! DUJ. HUPÉ, 1862. Échin., p. 520.
" " ! PERRIER, 1869. Pédicel., p. 144.
" " VERRILL, 1871. Notes on Radiata, p. 580.
Agarites " ! AGASS. 1846. C. R. Ann. Sc Nat., VI. p. 353.
Echinocidaris **Schythei** PHIL. 1857. Wieg. Archiv, I. p. 13. So. Extrem. So. Am.
" *Schythei* DUJ. HUPÉ, 1862. Échin., p. 521.
" " PERRIER, 1869. Pédic., p. 145.

*So. Am. So. Extrem.; W. Coast Patagonia! Straits Magellan! (Brit. Mus.); Chili! (Écol. Min.); ?? Madeira! (J. d. P.)

Arbacia nigra

Echinus niger **Mol.** 1782. Chili, p. 175 (non RUMPH). Chili.
Echinocidaris nigra ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354. Peru.
" " MÜLL. 1854. Bau d. Echin., *Pl. III. f. 1, 2.*
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 19, 20.*
" " ! DUJ. HUPÉ. 1862. Échin., p. 521.
" " ! PERRIER, 1869. Pédic., p. 145.
" " DESML. 1871. Act. Soc. Linn. Bord., XXVII., *Pl. XI. f. 7, 8.*
Tetrapygus niger ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354.
Arbacia nigra ! A. AGASS. 1863. Bull. M. C. Z., I. p. 20.
" " ! VERRILL, 1867. Notes on Radiata, p. 301.
Echinocidaris pustulosa DESML. 1837. Syn., p. 304 (non AGASS.).
Echinus (*Agarites*) **purpurescens** ! VAL. 1846. Voyage Vénus, Zooph., *Pl. V. f. 1.* Peru.

*Coquimbo, Chili (D'Orbigny); *Mexillones, *Iquique (Dillingham, Putnam); *Valparaiso, *Callao (Edwards); *Caldera (Putnam); whole coast Chili (Philippi); Cape Horn! (Mus. Berl.); ? Philippine Islands! (Semper).

Arbacia punctulata

Echinus nodiformis ...... SEBA, 1758. Thes., III. *Pl. X. f. 10, a b?*
...... KNORR, 1771. Delic., *Pl. D. I. f. 9; Pl. D. III. f. 6.*
Echinus **punctulatus** ! LAMK. 1816. An. s. Vert., p. 47. Grandes Indes?
" *punctulatus* ! BLAINV. 1825. Dict. Sc. Nat. O., p. 75.
" " ! BLAINV. 1834. Actin., p. 226.
Arbacia *punctulata* ! GRAY, 1835. Proc. Zoöl. Soc. Lond., p. 58. (Not Phil. Mag., as says DESML.)
Arbacia " ! AGASS. 1836. Prod., p. 23.
Echinocidaris " DESML. 1837. Syn., p. 306.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353. W. Indies, So. Ca.
" " ! DUJ. HUPÉ, 1862. Échin., p. 520.
" " ! LÜTK. 1864. Bid., p. 97.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. Straits Florida.
" " ! PERRIER, 1869. Pédic., p. 144.
" " DESML. 1871. Act. Soc. Linn. Bord. XXVII. *Pl. X. f. 1, 2.*
Agarites " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353.
Echinocidaris **Davisii** ! A. AGASS. 1863. Bull. M. C. Z., p. 20. Naushon.

*Naushon (A. Agassiz); *Newport (Wyman); *Cape Fear, 7 fms.; *Florida, off Tortugas, 13, 35, 36, 37, 44, 87, 125 fms.; *Sand Key, 20, 120 fms. (Pourtalès); Fort Monroe! Captiva Key, Fla.! (Smithson. Coll.); *Beaufort, N. C. (Bickmore); *Charleston, S. C. (Agassiz); *Charlotte Harbor (Maslin, Würdeman); *E. coast Fla. (Burkhardt); *Savannah, Ga. (Agassiz); *Indian Key (Würdeman); *Key West (Agassiz); *Hayti (Weinland).

Arbacia pustulosa

Cidaris *assulata pustulosa* KLEIN, 1734. Nat. Disp. Echin., *Pl. XI. f.* A, B.
Echinus **lixula** LINN. 1758. Syst. Nat.
" *Kermesinus* ...... SEBA, 1758. Thes., III. *Pl. X. f. 8, 15.*
...... KNORR, 1771. Delic., *Pl. D. f. 7.*
Cidaris **pustulosa** LESKE, 1778. KLEIN, Add, p. 85, *Pl. XI. f.* A, B.
Echinus pustulosus GMEL. 1788. LINN. Syst. Nat., 3179.
" " ! LAMK. 1816. A. s. V.
" " DESLONG. Enc. Méth., *Pl. CXLI. f. 6, 7.*
" " ! BLAINV. 1825. Dict. Sc. Nat. O., p. 75.
" " ! BLAINV. 1834. Actin., p. 226, *Pl. XX. f. 2.*
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XIII. f. 3.*
Arbacia *pustulosa* ! GRAY, 1835. Proc. Zool. Soc. Lond., April.
Arbacia " ! AGASS. 1836. Prod., p. 23.
Echinocidaris pustulosa ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354 (non DESML.). Brazil.
" " ! DUJ. HUPÉ, 1862. Échin., p. 521.
" " ! PERRIER, 1869. Pédic., p. 144.
Tetrapygus " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354.
Echinus **aequituberculatus** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 76.
" *aequituberculatus* ! BLAINV. 1834. Actin., p. 226.
Echinocidaris aequituberculata DESML. 1837. Syn., p. 306.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354, *Pl. XV. f. 3.* Palermo, Algeria.
" " ARADAS, 1853. Monog. Ech. Atti. Gioen. VIII. p. 87. Sicily.
" " MÜLL. 1854. Abhdl., VII. *Pl. II., III., IV.* (Pluteus).
" " SARS, 1857. Middelh. Litt. Faun., p. 110. Naples.
" " BRONN, 1859. Kl. u. Ord. Actin, p. 338.
" " ! DUJ. HUPÉ, 1862. Échin., p. 521.
" " ! DESML. 1871. Act. Soc. Linn. Bord., XXVII. *Pl. XI. f. 5, 6.*
Tetrapygus aequituberculatus ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354.
Arbacia equituberculata GRAY, 1835. Proc. Zoöl. Soc. Lond., p. 38.
Arbacia aequituberculata A. AGASS. 1863. Bull. M. C. Z., I. p. 20. Fayal.
Echinus **loculatus** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 75.
" *loculatus* ! BLAINV. 1834. Actin., p. 226.
Agarites loculatus AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353.
Echinocidaris loculata ! DESML. 1837. Syn., p. 306.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353. La Rochelle.
" " ! DUJ. HUPÉ, 1862. Échin., p. 521.
" " ! DESML. 1871. Act. Soc. Linn. Bord., XXVI. *Pl. X. f. 3, 4.*
Echinus **neapolitanus** DELLE CHIAJE 1825. An. senz. Vert.
" (*Agarites*) **grandinosus** ! VAL. 1846. Voyage Vénus, *Pl. XI. f. 1.*
Echinocidaris grandinosa ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354. Carthagena.
" " ! DUJ. HUPÉ, 1862. Échin., p. 521.
" " ! PERRIER, 1869. Pédic., p. 145, *Pl. IV. f. 7.*
Tetrapygus grandinosus ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 354.
Echinocidaris **sinensis** MICH. MS. (Coll. Cotteau).

*Palermo; *Naples (Panceri); *Fayal (Dabney, Higginson); *W. coast Italy (Rigacci); *Cape Verde Islands (Bouvier); *Liberia; *Cape Palmas (Perkins); W. coast Africa! (J. d. P.); La Rochelle (imported, Desml.); Madeira! (Smithson. Coll.); Dalmatia (Müller); Lessina, Lissa, (Heller); *Desterro, Brazil, (Fritz Müller); *Rio Janeiro (Agassiz, Thayer Exp.); *Isla de Marecas, *Armaçao (Hartt, Thayer Exp.); Brazil! (J. d. P.).

Arbacia spatuligera

Echinus (*Agarites*) spatuliger ! VAL. 1846. Voyage Vénus, *Pl. V. f. 2.*
Echinocidaris spatuligera ! AGASS. 1846. Cat. R. Ann. Sc. Nat., VI. p. 353. Coquimbo.
" " ! DUJ. HUPÉ, 1862. Éch., p. 520.
" " ! VERRILL, 1867. Notes Radiata, p. 300. Peru.
" " ! PERRIER, 1869. Pédic., p. 144.
Agarites " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353.

*Callao (Edwards; Bradley, Yale Coll.); *W. coast S. Am. (J. d. P.); Paita! (Yale Coll.); Coquimbo! (J. d. P.); Guayaquil! (Mus. Cop.); whole coast Chili (Philippi).

Arbacia stellata

Echinus stellatus ! (**Blainv.**) 1825. Dict. Sc. Nat. O., p. 76 (non GMEL.)
" " ! BLAINV. 1834. Actin., p. 226.
Arbacia *stellata* ! GRAY, 1835. Proc. Zoöl. Soc. Lond., p. 38.
Echinocidaris stellata DESML. 1837. Syn., p. 306.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353. Galapagos.
" " ! DUJ. HUPÉ, 1862. Échin., p. 520.
" " ! VERRILL, 1867. Notes Radiata, p. 298. Peru, San Salvador.
" " ! PERRIER, 1869. Pédic., p. 144.
Agarites stellatus ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 353.
Echinocidaris **incisa** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 20. Panama, Guaymas.
" **longispina** ! LÜTK. 1864. Bid., p. 130, *Pl. I. f. 7.* Realejo.

*Panama (Sternberg, Edwards); *Sta. Barbara (Jewett); *Guaymas (Stone); *Margarita Bay, Califa (Essex Inst.); *Zorritos (Bradley, Yale Coll.); Galapagos! (J. d. P.); La Union! (Yale Coll.).

ASTHENOSOMA.

Asthenosoma GRUBE, 1867. Jahresb. d. Schles. Ges.
Calveria W. THOMS. 1869. Dredging Report Porcup. Exped., Proc. R. S.

Asthenosoma hystrix

Calveria hystrix ! W. THOMS. 1869. Dredging Report Porcupine. Atlantic, deep sea.
Calveria hystrix ! A. AGASS. 1871. Bull. M. C. Z., II. p. 457.

*Straits of Florida, 138 fms. (Pourtalès); *between Rockall and Rona, 547 fms. off Vigo, S. Cape Finistère (Porcupine Exped.).

Asthenosoma varium

Asthenosoma varium ! GRUBE, 1867. Jahresb. d. Schles. Ges., p.

China Seas! (Breslau Mus.).

(MELLITA.) ASTRICLYPEUS.

Astriclypeus VERRILL, 1867. Notes Radiata, p. 311.
Crustulum TROSCH. 1868. Bonn. Jubilaeun d. Fried. Wilh. Univ.

Astriclypeus Manni

Astriclypeus Manni ! VERRILL, 1867. Notes on Radiata, p. 311.
Astriclypeus Manni ! A. AGASS. 1869. Bull. M. C. Z. Japan.
Crustulum gratulans ! TROSCHEL, 1868. Bonn., *Pl. I.*
Crustulum gratulans ! TROSCHEL, 1869. Verhandl. N. H. Ver. Preuss. Rheinl., p. 96.
" " ! TROSCHEL, 1869. Wieg. Arch., I. p. 52. Japan.

*Linguin, China Seas (Liv'p'l Mus.); *Japan (Salmin); Yokohama! (Martens).

ASTROPYGA.

Cidaris LESKE, 1778. KL. Add. (pars.)
Echinus GMEL. 1788. LINN. Syst. N. (pars.)
Cidarites LAMK. 1816. An. s. V. (pars.)
Astropyga GRAY, 1825. Ann. Phil., p. 4.
Diadema DESML. 1837. Syn. (pars.)
Astropyga AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 345. (pars.)
" PETERS, 1855. Seeig. v. Mossamb., p. 112.

Astropyga pulvinata

Cidarites **pulvinata** ! LAMK. 1816. An. s. Vert., p. 59.
Diadema pulvinatum ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 312.
Astropyga pulvinata ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 345.
" " ! BÖLSCHE, 1865. Wieg. Arch., I. p. 336.
" **dubia** ! PETERS, 1853. Monatsb. Berl. Ak., p. 484.
" *dubia* ! PETERS, 1855. Seeig. v. Mos., p. 114, *f. 2.*
" " ! BOLSCHE, 1865. Wieg. Arch., I. p. 335.
" **depressa** ! GRAY, 1855. Proc. Zool. Soc. Lond., p. 38.
" *depressa* ! BOLSCHE, 1865. Wieg. Arch., I. p. 336.
" " ! VERRILL, 1871. Notes Radiata, p. 579.
" **venusta** ! VERRILL, 1867. Notes Radiata, p. 296. Panama.

*San Salvador (Dow, Smithson. Coll.); *Panama (Bradley, Yale Coll.); La Paz ! (Yale Coll. Pedersen); Mazatlan ! (Mus. Stockholm, Copenh., Berlin, Hamburg).

Astropyga radiata

Echionanthus major ...... SEBA, 1758. Thes., III. *Pl. XIV. f. 1, 2.*
Cidaris **radiata** LESKE, 1778. KL. Ech., *Pl. XLIV. f. 1.* Copied from Seba in Enc. M., *Pl. CXL. f. 5, 6.*
" *radiata* BLAINV. 1834. Actin., p. 232, *Pl. XX^bis f. 7.*
Echinus radiatus GMEL. 1788. LIN. Syst. Nat., 3174.
Cidarites radiata ! LAMK. 1816. An. s. Vert., p. 59. Asia.
Astropyga *radiata* ! GRAY, 1825. Ann. Phil., p. 2. ? S. Am.
Astropyga " ! AGASS. 1836. Prod., p. 22.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 345.
" " ! PETERS, 1855. Seeig. v. Mos., p. 112, *f.* 5, 6. Mozambique.
" " ! DUJ. HUPÉ, 1862. Échin., p. 506.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 18.
" " ! MARTENS, 1866. Wieg. Archiv, I. p. 158. Molucca, Amboina.
" " ! PERRIER, 1869. Pédic, p 137.
Diadema radiatum DESML. 1837. Syn., p. 312.
Astropyga **major** BÖLSCHE, 1865. Wieg. Arch., I. p. 335.
" **mossambica** ! PET. 1853. Monatsb. Berlin Ak., p. 484. Mozambique.
" *mossambica* ! PET. 1855. Seeig. v. Moss., p. 112, *f* 1.
" " ! BÖLSCHE, 1865. Wieg. Arch., I. p. 335.

*Zanzibar (Ropes, Essex Inst.); *Mauritius (Pike); Mozambique ! (Peters); Philippine Islands ! (Semper); Timor, Molucca (Martens); Borneo ! (Brit. Mus.).

BREYNIA.

Spatangus LEACH, 1815. Zoöl. Miscell.
Brissus AGASS. 1836. Prod. (pars.)
Breynia DES. 1847. AG. C. R. Ann. Sc. Nat., VIII. p. 12.

Breynia Australasiae

Spatangus **Australasiae** LEACH, 1815. Zoöl. Miscell., II. p. 68. Australia.
Breynia Australasiae ! GRAY, 1855. Cat. Rec. Ech., p. 46.
" " ! GRAY, 1851. Ann. Mag. N. H., VII. p. 131.
Spatangus **Crux Andreae** ! LAMK. 1816. An. s. Vert., p. 31. So. Pacific.
" *Crux Andreae* DESML. 1837. Syn., p. 378. Red Sea.
Breynia *Crux Andreae* ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 12, *Pl. XVI. f. 1.*
Breynia Crux Andreae ! DUJ. HUPÉ, 1862. Échin., p. 601.
" **Desorii** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 131. Swan Riv.
" *Desorii* ! GRAY, 1855. Cat. R. Ech., p. 46.
" **Leachei** GRAY. MS. (Brit. Mus.).

*Australia, Port Jackson (U. S. Ex. Exp. Smithson. Coll.); *Australian Ocean; Hong Kong! (Vienna Mus.); Swan Riv.! W. Australia, King George's Sound! (Brit. Mus.); Red Sea, (Savigny); Hakodadi! (W. Stimpson, Smithson. Coll.).

(HEMIASTER.) BRISSOPSIS.

Brissopsis AGASS. 1840. Cat. Syst. Ectyp., p. 16.
Brissus FORBES, 1841. Brit. Starfish.
Brissopsis AGASS. 1846. C. R. Ann. Sc. N., VIII. p. 15.
Brissiopsis GRAY, 1848. Brit. Rad.
Kleinia GRAY, 1851. Ann. Mag. N. H., VII. p. 133 (non A. AGASS.).
Cyclaster COTT. 1856. Bull. Soc. Géol. fr. p. 319.
Toxobrissus DES. 1858. Synops. Éch. foss., p. 399.
Hemiaster DES. 1847. C. R. Ann. Sc. Nat., VIII.

Brissopsis luzonica

Kleinia luzonica ! GRAY, 1851. Ann. Mag. N. H., VII. p. 133. Philippine Islands.
Kleinia luzonica ! GRAY, 1855. Cat. R. Echin., p. 49, *Pl. IV. f. 5.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 599.

*Formosa (Mus. Godeff.); *Siam (Salmin); New Caledonia! (Crosse); Banca Straits! (Salmin); East India! (Mus. Godeff.); Luzon! (Brit. Mus.).

Brissopsis lyrifera

KNORR, 1771. Delic., *Pl. D. II. f. 6, 7.?*
Brissus **lyrifer** ! FORBES, 1841. Brit. Starf., p. 187, fig. Isle of Man.
" *lyrifer* ! DÜBEN och KOREN, 1844. Skand. Echin., p. 280, *Pl. X. f. 46.* Norway.
Brissopsis lyrifera ! AGASS. DES. 1847. C. R. Ann. Sc. Nat., VIII. p. 15, *Pl. XVI. f. 12.*
" " MÜLL. 1854. Bau d. Echin., *Pl. III. f. 6, 7.*
" " BRONN, 1859. Kl. u. Ord. Actinoz., *Pl. XXXIX. f. 21; Pl. XLII. f. 6.*
" " ! SARS, 1861. Norges Ech, p. 96.
" " DUJ. HUPÉ, 1862. Échin., p. 597.
" " ! LÜTK. 1864. Bid., p. 181.

Brissopsis lyrifera (*continued*).

Brissopsis lyrifera ! A. AGASS. 1869. Bull. M. C. Z., p. 275.
" *lyrifer* ! PERRIER, 1869. Pédic., p. 173, *Pl. VII. f. 9.*
Brissiopsis *lyrifera* ! GRAY, 1848. Brit. Rad., p. 7.
Brissiopsis " GRAY, 1855. Cat. R. Echin., p. 55. Shetland.
Brissus **pulvinatus** PHIL. 1845 Wieg. Arch., I. p. 348. Sicily.
Schizaster **incertus** ARADAS, 1850. Monog. Ech. Atti. Gioen., VI. p. 91.
Brissopsis **parma** ! VAL. 1869. In PERR. Pédic., p. 178.

*Dröback (Eschricht); *Christianiafjord (G. O. Sars); *W. coast Norway, Bergen (Sars); *Great Britain; Greenland, Clyde (Forbes); Isle of Man (Gray); *off Valencia (Porcup. Exp.); *Mediterranean, Adventure Bk. (Porcup. Exp.); *W. coast Italy (Rigacci); *Mediterranean (Cotteau); Naples, Palermo (Philippi); *off Alligator Reef, 53, 79 fms., *off Marquesas, 55 fms., *Florida Gulf Stream, 55, 79, 128 fms., *Sombrero, 112 fms., *Tennessee Reef, 114 fms. (Pourtalès).

BRISSUS.

Brissus KLEIN, 1734. Nat. Disp. Echin.
Echinus GMEL. 1788. Syst. Nat. (pars.)
Spatangus LESKE, 1778. KL. Addit. (pars.)
Brissus AGASS. 1849. C. R. Ann. Sc. Nat., VIII.
Bryssus MART. 1869. Decken's Reise.

Brissus carinatus

...... SEBA, 1758. Thes., III. *Pl. XIV. f. 3, 4.*
...... E. M., *Pl. CXLVIII. f. 11.*
Spatangus ...... LESKE, 1778. KL. Ad., p. 249, *Pl. XLVIII. f. 4, 5.*
Spatangus **carinatus** ! LAMK. 1816. An. s. Vert., p. 30. Mauritius, So. Pacific.
" *carinatus* ! BLAINV. 1834. Actinol., p. 203.
" " DESML. 1837. Syn., p. 380.
Brissus " ! GRAY, 1825. Ann. Phil., p. 9.
" " ! AGASS. 1836. Prod., p. 185.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 7.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 13.
" " ! GRAY, 1855. Cat. R. Echin., p. 53.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.
" " ! MART. 1866. Wieg. Arch., I. p. 181.

*Society Islands, *Sandwich Islands, *Kingsmills Islands (Garrett); *East Indies (Swift); *Bourbon (J. d. P.); *Mauritius (Pike); *Isle de France; Philippine Islands! (Semper); Feejee Islands! Pelew Islands! (Mus. Godeff.).

Brissus obesus

Brissus **obesus** ! VERRILL, 1867. Notes Radiata, p. 316. Gulf Califa.
" *obesus* ! VERRILL, 1869. Proc. Boston Soc. N. H., p. 382.
" " ! VERRILL, 1871. Notes Radiata, p. 589. Cape St. Lucas.

*La Paz; *Panama (Jewett); Cape St. Lucas! (Smithson. Coll.).

Brissus unicolor

Brissus unicolor ! KLEIN, 1734. Echin. ......, *Pl. XXVI. f. B, C.*
Brissus unicolor LESKE, 1778. KLEIN, Ad., *Pl. XXVI. f. B, C.*
Spatangus unicolor ! BLAINV. 1834. Actinol., p. 203.
" " ! DESML. 1837. Syn., p. 382.
...... SLOANE, 1725. Jam., *Pl. CCXLII. f. 3 – 5.*
...... SEBA, 1758. Thes., III. *Pl. X. f. 19, 19 a.* Copied, E. M., *Pl. CLVIII. f. 9 10.*
...... KNORR, 1771. Delic., *Pl. D. I. f. 13.*
Spatangus Brissus var. *ovatus* LESKE, 1778. KL., *Pl. XXXVIII. f. 4.* Copied from KNORR.
Echinus **ovatus** GMEL. 1788. LINN. Syst. Nat., 3199.
Spatangus ovatus LAMK. 1816. A. s. V. p. 30 (non LESKE).
" **columbaris** ! LAM. 1816. A. s. V., p. 30. Americ. Ocean.
" *columbaris* ! BLAINV. 1834. Actinol., p. 203.
" " DESML. 1837. Syn., p. 384.
Brissus columbaris ! GRAY, 1825. Ann. Phil., p. 9.
" " ! AGASS. 1836. Prod., p. 185.
" " ! AGASS. DES. 1847. C. R. Ann. Sc. Nat., VIII., p. 13. Cuba.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.
" " ! LÜTK. 1864. Bid., p. 118.
" **columbarius** ! GRAY, 1855. Cat. R. Echin., p. 54, *Pl. VI. f. 3.* West Indies.
" *carinatus* RISSO, 1826. Prod. Eur. Mér., V. p. 279 (non LAMK.).
" " ARADAS, 1853. Monog. Ech. Atti. Gioen., VI. p. 83.
" **Scillae** ! AGASS. 1836. Prod., p. 185.
" *Scillae* ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 13, *Pl. XVI. f.* 9. Mediterranean.
" " ! GRAY, 1855. Cat. R. Ech., p. 52.
" " ! BRONN, 1859. Klass. u. O. Actin., *Pl. XLII. f. 3.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 605, *Pl. IX. f. 7.*
" **placenta** PHIL. 1845. Wieg. Arch., I. p. 349. Sicily.
" **dimidiatus** ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 13. Canary Islands.
" *dimidiatus* GRAY, 1855. Cat. R. Ech., p. 52.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.

*Tortugas, Fla. (Whitehurst); *Cape Florida (Würdeman); *Jeremie, Hayti (Weinland); *Bermudas; *Jamaica (Adams); *Gulf Stream, Fla., 128, 106, 80, 17 fms., *Sand Key (Pourtalès); Cuba! (Arango); Guadeloupe! (Mus. Copenh.); *Mediterranean; *Naples (Panceri); *W. coast Italy (Rigacci); *Canaries, Lazarote (Haeckel); *Cape Verde Islands (Bouvier); Palermo (Gray).

(DIADEMA.) CENTROSTEPHANUS.

Diadema PHIL. 1845. Wieg. Archiv, p. 354. (pars.)
Centrostephanus PET. 1855. Denk. Ak. Berlin, p. 109.
Thrichodiadema A. AGASS. 1863. Proc. A. N. S., Phila.
Echinodiadema VERRILL, 1867. Notes Radiata.

Centrostephanus coronatus

Echinodiadema coronata ! VERRILL, 1867. Notes Radiata, p. 294. Cape St. Lucas.
Echinodiadema coronata ! VERRILL, 1871. Notes Radiata, p. 580.
Diadema **mexicanum** ! A. AGASS. pars, 1869. Bull. M. C. Z., I. p. 282.
Thrichodiadema coronatum ! A. AGASS. MS.

Cape St. Lucas! (Xanthus, Smithson. Coll.).

Centrostephanus longispinus

Diadema **longispina** Phil. 1845. Wieg. Arch., I. p. 354. Sicily.
" *longispina* Bolsche, 1865. Wieg. Arch., I. p. 327.
Centrostephanus *longispinus* ! Pet. 1854. Seeig. v. Moss., p. 109.
Diadema **europaeum** ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 346. Palermo.
" *europaeum* Aradas, 1853. Monog. Ech. Atti. Gioen., VIII. p. 168.
" " ! Duj. Hupé, 1862. Échin., p. 505.

Palermo (Philippi); Canary Islands (Forbes); Madeira! (J. d. P.); Mediterranean! (Écol. Min.).

Centrostephanus Rodgersii

Thrichodiadema Rodgersii ! A. Agass. 1863. Proc. A. N. S. Phila., p. 354. Port Jackson.
Thrichodiadema Rodgersii Bölsche, 1865. Wieg. Arch., I. p. 336.

*Port Jackson (Stimpson)! *Houtman's Abrolhos (Liv'p'l Mus.); Bondy Head! Tasmania! (Brit. Mus.); New Caledonia! (Leipzig Mus.).

CIDARIS.

Cidaris Klein, 1734. Nat. Disp. Ech. (pars.)
Cidarites Lam. 1816. An. s. Vert. (pars.)
Leiocidaris Duj. Hupé, 1862. Échin. (pars.)
Cidaris Agass. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Gymnocidaris A. Agass. 1863. Bull. M. C. Z., I. p. 17.

Cidaris metularia

...... Rumph, 1705. Amb. Rarit Kam. *Pl. XIII. f. 4.*
Echinometra muscosa amboinensis Seba, 1758. Thes., III. *Pl. XIII. f. 10, 11.* Copied in DesLong. En. Méth., *Pl. CXXXIV. f. 8.*
...... Leske, 1778. Kl. Ad., *Pl. XXXIX. f. 4.*
Cidarites **metularia** ! Lamk. 1816. An. s. Vert., p. 56 (non Lütk.). Isle de France.
" *metularia* Desml. 1837. Syn., p. 324.
Cidaris " ! Blainv. 1830. Actin., p. 232.
" " ! Agass. 1836. Prod., p. 21.
" " ! Mich. 1845. Rev. Mag. Zoöl., p. 17.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 326. Seychelles, Salomon.
" " ! Duj. Hupé, 1862. Échin., p. 470.
" " ! Mart. 1866. Wieg. Arch., I. p. 142. Amboina, Red Sea.
" " ! Perrier, 1869. Pédic, p. 125, *Pl. III. f. 2.*
Gymnocidaris *metularia* ! A. Agass. 1863. Bull. M. C. Z., I. p. 17. Zanzibar.
" **minor** ! A. Agass. 1863. Bull. M. C. Z., I. p. 17. Sandwich Islands.

*Red Sea (J. d. P.); *Zanzibar (Cooke, Ropes, Webb); *Salomon Islands (J. d. P.): *Sandwich Islands, Kingsmills (Garrett); *Mauritius (Pike); Madagascar! Seychelles! Isle de France! (J. d. P.); So. China Sea, 40 fms.; Amboina (Martens); Philippine Islands! (Semper); Feejee Islands! (Mus. Godeff.); Cape Good Hope! (Brit. Mus.).

Cidaris Thouarsii

Cidaris **Thouarsii** ! Val. 1846. Ag. Des. C. R. Ann. Sc. Nat., VI. p. 326. California, Galapagos.
" *Thouarsii* ! A. Agass. 1863. Bull. M. C. Z, I. p. 17. Panama.
" " ! Verrill, 1867. Notes Radiata, p. 294.
" " ! Verrill, 1871. Notes Radiata, p. 579. La Paz.
Leiocidaris " ! Duj. Hupé, 1862. Échin., p. 485.
" " ! Perrier, 1869. Pédic., p. 130, *Pl. III. f. 8, 10.*

Cidaris Thouarsii (*continued*).

Cidaris **Danae**! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 326.
Leiocidaris Danae! DUJ. HUPÉ, 1862. Échin., p. 485. California.
Cidaris **Callao**! PERRIER, 1869. Pédic., p. 129. Callao.

*Guaymas (Capt. Stone); Gulf Calif.! (Mus. Copenh.); *Galapagos; *Panama (Adams, A. Agassiz, Jewett); *Cape St. Lucas, *Manzanillo! (Xanthus, Smithson. Coll.); Pearl Islands! (Bradley, Yale Coll.); La Paz! (Yale Coll.).

Cidaris tribuloides

...... SLOANE, 1725. Jam., *Pl. CCXLIV. f. 4-7.*
...... KNORR, 1771. Delic., *Pl. D. III. f. 5.* Copied in LESKE, *Pl. XXXVII. f. 3.*
Cidarites **tribuloides**! LAMK. 1816. An. s. Vert., p. 56. Indian Ocean.
" *tribuloides* DESML. 1837. Syn., p. 322.
" " DESLONG. 1824. E. M., *Pl. CXXXVI. f. 4, 5.*
Cidaris " ! BLAINV. 1830. Dict. S. Nat., p. 200.
" " ! AGASS. 1836. Prod., p. 21.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XII. f. 1, 2.*
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI., p. 326. Cuba.
" " MÜLL. 1854. Bau d. Ech., *Pl. II. f. 7.*
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 1.*
" " ! DUJ. HUPÉ, 1862. Éch., p. 470.
" " ! STEWART, 1865. Trans. Lin. Soc., XXV., *Pl. XLVII. f. 5, 6*; *Pl. XLVIII. f. 3, 5, 11.*
" " ! MART. 1866. Wieg. Arch., I. p. 143.
" " ! PERRIER, 1869. Pédic., p. 126.
" *annulata*! A. AGASS. 1863. Bull. M. C. Z., p. 17 (non GRAY). Florida.
" " ! STEWART, 1870. Mic. Jour., XI. *Pl. IV.*
" *metularia*! LÜTK. 1864. Bid. p. 79 (non LAMK. nec AGASS.). W. Indies.

*Tortugas (Agassiz, Dr. Holder, Mills, Woodbury); *Hayti (Weinland, Uhler); *Florida Gulf Stream, 116 fms. (Pourtalès); *Cuba (Arango); *Tortugas, 36, 30 fms., *Cuba (Pourtalès); *Aspinwall (Bradley, Yale Coll.); *Gulf of Mexico; *Cape Palmas (Perkins, Essex Inst.); *Cape Verde Islands (Bouvier); Rio Janeiro! (Mus. Copenh.); So. Carolina! (Gibbes).

CLYPEASTER.

Echinanthus BREYN. 1732. Schedias. (pars.)
Scutum KLEIN, 1734. Nat. Disp. Echin. (pars.)
Echinus LIN. 1758. Syst. Nat. (pars.)
Echinodiscus LESKE, 1778. KL. Addit. (pars.)
Scutella LAMK. 1816. An. s. Vert. (pars.)
Clypeaster LAMK. 1816. An. s. Vert. (pars.)
Echinanthus GRAY, 1825. Ann. Phil. (pars.)
Lagana GRAY, 1825. Ann. Phil. (pars.)
Echinarachnius AGASS. 1836. Prod. (pars.)
Laganum DES. 1857. Syn. Éch. foss. (pars.)
Clypeaster MÜLL. 1854. Bau d. Echin.
Laganinum GRAY, 1855. Cat. R. Echin.
Stolonoclypus AGASS. 1863. Bull. M. C. Z.
Raphidoclypus A. AGASS. 1863. Bull. M. C. Z.
Stoloniclypeus VERRILL, 1867. Notes Radiata.

Clypeaster humilis

...... Rumph, 1705. Rarit. Kam., *Pl. XIV. f. C.*
...... Seba, 1758. Thes., III. *Pl. XV. f. 13, 14.*
Scutum *angulare humile* ! Klein, 1734. *Pl. XIX. f. A, B.*
Echinanthus **humile** Leske, 1778. Kl. Add., *Pl. XIX. f. A, B.*
Echinus **rosaceus** Linn. 1758. Syst. Nat. X. p. 665. (pars.)
" *rosaceus* Gmel. 1788. Lin. Syst. N., 3186. (pars.)
Scutella placunaria ! Lamk. 1816. An. s. Vert., p. 12. Australian Ocean.
Scutella placunaria Desml. 1837. Syn., p. 228.
Echinodiscus placunarius ! Blainv. 1834. Actinol., p. 218.
Echinarachnius placunarius ! Agass. 1837. Prod., p. 188.
Clypeaster placunarius ! Agass. Des. 1847. C. R. Ann. Sc. Nat., VII. p. 130. Red Sea.
" " Müll. 1854. Bau d. Echin., *Pl. III. f. 8–14 : Pl. IV. f. 8.*
" " Bronn, 1859. Kl. u Ord. Actin., *Pl. XXXIX. f. 3, 11, 12, 23, 25.*
" " Mich. 1861. Clyp., *Pl. XIV. f. 1.*
" " ! Duj. Hupé, 1862. Échin., p. 571.
Echinanthus " ! Gray, 1855. Cat. R. Ech., p. 7. Muscat.
Scutella ambigena ! Lamk. 1816. An. s. Vert., p. 12.
Scutella ambigena ! Blainv. 1827. Art. Scut. D. S. N., p. 229.
" " Desml. 1837. Syn., p. 228.
Echinanthus ambigena ! Gray, 1825. Ann. Phil., p. 5.
Clypeaster ambigenus ! Blainv. 1834. Actin., p. 216.
" " Desml. 1837. Syn., p. 214.
Scutella latissima ! Lamk. 1816. An. s. Vert., p. 12. Ocean Austral.?
Scutella latissima Desml. 1837. Syn., p. 228.
Echinodiscus latissimus ! Blainv. 1834. Actinol., p. 218.
Echinarachnius latissimus ! Agass. 1836. Prod., p. 188.
Laganum latissimum ! Agass. Des. 1847. C. R. Ann. Sc. Nat., VIII. p. 27.
? " " Hupé, 1856. In Casteln. Voy., p. 1, Zooph.
Laganinum *latissimum* ! Gray, 1855. Cat. R. Ech., p. 11.
Clypeaster **Rumphii** Desml. 1837. Syn., p. 216.
Echinanthus **explanatus** ! Gray, 1851. Proc. Zoöl. Soc. Lond., p. 35. Mauritius.
" *explanatus* ! Gray, 1855. Cat. R. Ech., p. 7, *Pl. II. f. 1*
? " **productus** ! Gray, 1851. Proc. Zool. Soc. Lond., p. 35.
? " *productus* ! Gray, 1855. Cat. R. Ech., p. 6, *Pl. VI. f. 4.*
Clypeaster **Saisseti** ! Mich. 1861. Rev. Mag. Zool., p. 328, *Pl. IX. f. 2.* New Caledonia.

*Red Sea (J. d. P.); *Indian Ocean; *Calcutta (Theobald); Ceylon! (Humbert, Loriol.); Timor, (Martens); Muscat! (Brit. Mus.); New Caledonia! (Écol. Min.); Philippine Islands! (Semper).

Clypeaster rotundus

Stolonoclypus rotundus ! A. Agass. 1863. Bull. M. C. Z., I. p. 25. Acapulco.
Stoloniclypeus *rotundus* ! Verrill, 1867. Notes Radiata, p. 314. Panama.
Clypeaster **Riisei** ! Lütk. 1864. Bid., p. 132. Panama.

*Acapulco (A. Agassiz); *Panama! (Bradley, Yale Coll.); *Cape St. Lucas (Xanthus, Smithson. Coll.); San Diego.

Clypeaster scutiformis

Echinus **reticulatus** LINN. 1758. Syst. Nat., X. p. 666. (pars.)
Echinus reticulatus GMEL. 1788. LINN. Syst. Nat., 3191. (pars.)
Echinodiscus reticulatus LESKE, 1778. KL. Addit., p. 143, *Pl. XLV. f. 8, 9*, copied from GUALTERI, *Pl. CX. f. D.*
Scutella reticulata BLAINV. 1827. Art. Scut. D. S. N., p. 228.
Clypeaster reticulatus DESML. 1837. Syn., p. 214.
" " ! MART. 1866. Wieg. Archiv., I. p. 171.
Echinus planus scutiformis SEBA, 1758. Thes., III. *Pl. XV. f. 23, 24*, copied in E. M., *Pl. CXLVII. f. 3, 4.*
" **scutiformis** GMEL. 1788. LINN. Syst. Nat.
Clypeaster scutiformis ! LAMK. 1816. An. s. Vert., p. 14. Indian Ocean?
" " ! BLAINV. 1834. Actinol., p. 216.
" " ! AGASS. 1836. Prod., p. 187.
" " ! AGASS. DES. 1847. C. R. Ann. Sc. Nat., VII. p 130. Persian Gulf.
" " ! MICH. 1861. Clyp. Monog., *Pl. XVIII. f. 1.*
Lagana *scutiformis* ! GRAY, 1825. Ann. Phil., p. 6.
Echinanthus scutiformis GRAY, 1855. Cat. R. Ech, p. 5. Red Sea.
Laganum scutiforme DESOR, 1857. Synop. Echin., p. 228.
" " DUJ. HUPÉ, 1862. Échin., p. 559.
Rhaphidoclypus *scutiformis* A. AGASS. 1863. Bull. M. C. Z., p. 25.
Scutella **clypeastriformis** BLAINV. 1827. Art. Scut. Dict. S. N., p. 228.
" *clypeastriformis* DESML. 1837. Syn., p. 230.
Lagana **ovalis** BLAINV. 1834. Actinol., p. 215.
Scutella ovalis AGASS. 1836. Prod., p. 188.
Echinanthus **Coleae** ! GRAY, 1851. Proc. Zoöl. Soc. Lond., p. 35. Mauritius.
" *Coleae* ! GRAY, 1855. Cat. R. Ech., p. 6, *Pl. II. f. 3.*
" **oblongus** ! GRAY, 1851. Proc. Zoöl. Soc. Lond., p. 35. Philippines.
" *oblongus* ! GRAY, 1855. Cat. R. Ech., p. 6, *Pl. I. f. 3.*
Rhaphidoclypus microtuberculatus ! A. AGASS. 1863. Bull. M. C. Z., p. 25. Kingsmills Islands.

*Red Sea; *Bourbon (J. d. P.); *Krusenstern Island; *Kingsmills Islands (Garrett); Persian Gulf! Siguigor, Philippine Islands! (Brit. Mus.); Formosa! (Mus. Godeff.); Timor, Flores (Martens).

Clypeaster subdepressus

Scutum *angulare humile* ! KLEIN, 1734. *Pl. XIX. f. C, D.*
Echinanthus **subdepressus** ! GRAY, 1825. Ann. Phil., p. 5.
" *subdepressus* ! GRAY, 1855. Cat. R. Echin., p. 7. E. (W.) coast Africa.
Clypeaster " ! AGASS. 1836. Prod., p. 187.
" **Rangianus** DESML. 1835. Étud. s. Échin., p. 62, *Pl. I.* W. coast Africa.
" *Rangianus* DESML. 1837. Syn., p. 214.
" " AGASS. DES. 1847. Ann. Sc. Nat., VII. p. 130.
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 13, 18.*
" " DUJ. HUPÉ, 1862. Échin., p. 571.
Echinanthus " MÜLL. 1854. Bau d. Echin., *Pl. IV. f. 2; Pl. V. f. 1–4.*
Scutella gibbosa ! **(Rav.)** 1845. J. A. N. S. Phila., p. 253 (non RISSO nec SERRES).
Clypeaster **prostratus** ! RAV. 1848. Cat. Ech. So Ca. So. Carolina.
" *prostratus* ! LÜTK. 1864. Bid., p. 102, *Pl. II. f. 2.* W. Indies.
Stolonoclypus *prostratus* ! A. AGASS. 1863. Bull. M. C. Z., I. p. 125. Florida.
Stolonoclypus " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 2.
" **Ravenellii** ! A. AGASS. 1869. Bull. M. C. Z., 265. Straits of Florida.
Laganum latissimum ! HUPÉ, 1856. CASTELN., Voyage Am. Sud, p. 98 (non LAM.). Brazil.
Clypeaster ambigena ! MICH. 1861. Clypeast. foss. Mém. Soc. géol. Fr., *Pl. XV. f. 1* (non LAM.).
" **guadeloupensis** ! MICH. MS. (École. Min.) Guadeloupe.

*Tortugas (Agassiz); *Charleston, S. C. (Gibbes); Cuba! (Arango); *Carysfort Reef, 40 fms., *Florida Reef, *S. of Rebecca Shoal, 11, 15 fms., Gulf Stream, Fla., 34 fms. (Pourtalès); *Georgia (Liv'p'l Mus.); Isle des Princes! (J. d. P.); W. coast Africa! (Brit. Mus.); Brazil! (Casteln.).

COELOPLEURUS.

Coelopleurus AGASS. 1840. Cat. Syst. Ectyp.
Coelopleurus AGASS. 1846 C. R. Ann. Sc. Nat., VI.
Keraiaphorus MICH. 1862. MAILLARD, Bourbon. Ann. A.
Coelopleurus A. AGASS. 1871. Bull. M. C. Z., II.

Coelopleurus floridanus

Coelopleurus **sp.** ! A. AGASS. 1871. Bull. M. C. Z., II. p. 456. Straits of Florida.

*Off Tennessee Reef, 160 fms. (Pourtalès).

Coelopleurus Maillardi

Keraiaphorus Maillardi MICH. 1862. MAILLARD, Bourbon Annéx. A., p. 2, *Pl. XIV.* Bourbon.
Coelopleurus Maillardi A. AGASS. 1871. Bull. M. C. Z., II. p. 456.

Bourbon ! (École. Min. Maillard).

COLOBOCENTROTUS.

Echinus LINN. 1758. Syst. Nat. (pars.)
Cidaris LESKE, 1778. KLEIN, Addit. (pars.)
Echinometra GRAY, 1825. Ann. Phil. (pars.)
Colobocentrotus BRANDT, 1835. Prod., p. 266.
Echinometra DESML. 1837. Syn , p. 268. (pars.)
Colobocentrus GRAY, 1840. Syn. Brit. Mus.
Podophora AGASS. 1840. Cat. Syst. Ectyp.
Colobocentrotus A. AGASS. 1863. Proc. A. N. S. Phila., p. 354.
Podophora AGASS. 1846. C. R. Ann. Sc. Nat., VI.

Colobocentrotus atratus

Echinus **atratus** LINN. 1758. Syst. Nat., ed. X. p. 665.
" *atratus* GMEL. 1788. LINN. Syst. Nat., 3177.
" " ! BLAINV. 1825. Dict. Sc. Nat. O., p. 96.
Echinometra atrata ! GRAY, 1825. Ann. Phil., p. 5.
" " ! BLAINV. 1834. Actin., p. 225, *Pl. XX. f. 1.*
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 262.
" " EDW. in CUV. Règ. An. Ed. Ill , *Pl. XIII. f. 1.*
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 11. Isle de France.
Colobocentrotus *atratus* BRANDT, 1835. Prod., p. 267.
Podophora *atrata* ! AGASS. 1840. Cat. Syst. Ectyp.
Podophora " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 374. Seychelles Islands.
" " ! DUJ. HUPÉ, 1862. Échin., p. 541.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Mauritius.
" " ! STEWART, 1865. Trans. Linn. Soc., XXV. *Pl. II. f. 7.*
" " ! MART. 1866. Wieg. Arch., I. p. 168. Java, Molucca.
" " ! PERRIER, 1869. Pédic., p. 165, *Pl. VI. f. 8a.*
Colobocentrus atratus MÜLL. 1854. Bau d. Ech., p. 8.
Cidaris **violacea** LESKE, 1778. KL. Add., p. 53, *Pl. XLVII. f. 1, 2*; copied in Enc. Méth., *Pl. CXL. f. 1–4.*

Colobocentrotus atratus (*continued*).

Echinus **Quoy** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 96.
Echinometra Quoyii ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 262.
" " ! DUJ. HUPÉ, 1862. Échin., p. 539.
Colobocentrotus *Quoyi* BRANDT, 1835. Prod., p. 267.
Podophora " ! A. AGASS. 1863. Bull. M. C. Z., I. Sandwich Islands.
Echinus **pedifer** ! BLAINV. 1825. Dict. Sc. N. O., p. 97. Oahu.
Echinometra pedifera ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 23.
" " ! DESML. 1837. Syn., p. 264.
Colobocentrotus *pedifer* BRANDT, 1835. Prod., p. 267.
Podophora pedifera ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 370. ? Valparaiso.
" " ! DUJ. HUPÉ, 1862. Échin., p. 541.
Colobocentrotus Leskei BRANDT, 1835. Prod., p. 266 (non A. AGASS.).

*Zanzibar; *Seychelles Islands; *Mauritius (Pike); *Sandwich Islands (Garrett); Java, Moluccas (Martens); *Callao? Valparaiso? (U. S. Ex. Exp., Smithson. Coll.).

Colobocentrotus Mertensii

Colobocentrotus Mertensii BRANDT, 1835. Prod, p. 266. Bonin Islands.
Colobocentrotus Mertensii DUJ. HUPÉ, 1862. Échin., p. 541.
Echinometra " DESML. 1837. Syn., p. 268.
Colobocentrotus Leskei ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 354 (non BRANDT). Bonin Is.
Podophora **quadriseriata** TROSCHEL, 1869. Verhdl. d. Vaterländ, Cult. d. Rheinpf., p. 96.

*Bonin Islands (W. Stimpson, Smithson. Coll.); Australia (Troschel).

DIADEMA.

Diadema SCHYNV. 1711 (non SCHUM. 1817).
Cidarites LAMK. 1816. An. s. Vert. (pars.)
Diadema GRAY, 1825. Ann. Phil.
Cidaris BLAINV. 1834. Actin. (pars.)
Diadema AGASS. 1846. C. R. Ann. Sc. Nat., VI.
" PETERS, 1855. Denk. Ak. Berlin.
" BÖLSCHE, 1865. Wieg. Arch., I.

Diadema mexicanum

Diadema **mexicanum** ! A. AGASS. 1863. Bull. M. C. Z., p. 19. Acapulco.
" *mexicanum* ! BÖLSCHE, 1865. Wieg. Arch., I. p. 328.
" *mexicana* ! VERRILL, 1867. Notes Radiata, p. 294. Cape St. Lucas.

*Acapulco (A. Agassiz); *Cape St. Lucas (Xanthus, Smithson. Coll.).

Diadema setosum

...... SLOANE, 1725. Jam., *Pl. CCXLIII.*
...... KNORR, 1771. Delic, *Pl. DIII. f. 1, 2*, copied in LESKE, 1778, *Pl. XXXVII. f. 1, 2.*
Cidarites diadema ! (**Lam.**) 1816. An. s. Vert., p. 58 (non LIN.).
" " SAY, 1825. Journ. Ac. N. S. Phila., p. 225. Florida.
Cidaris " BLAINV. 1834. Actin., p. 231, *Pl. XX^{bis} f. 6.*

Diadema setosum (*continued*).

Diadema turcarum DESML. 1837. Syn., p. 308. (pars.)
" " ! MICH. 1845. Rev. Mag. Z., p. 15. (pars.) Isle de France.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 350. W. Indies.
" " ! DUJ. HUPÉ, 1862. Échin., p. 310.
" " PERRIER, 1869. Pédic., p. 135, *Pl. IV. f. 2c.*
" *setosa* ! (**Gray**,) 1825. Ann. Phil., p. 4 (non RUMPH.).
" *setosum* DESML. 1837. Syn., p. 310.
" *setosa* ! PETERS, 1854. Seeig. v. Moss., p. 109. Mozambique.
" " BÖLSCHE, 1865. Wieg. Arch., I. p. 325. W. Indies.
" **Savignyi** ! MICH. 1845. Rev. Mag. Z., p. 15. Isle de France.
" *Savignyi* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 349. Red Sea, Bombay, Seychelles, Madagascar.
" " ! DESOR, 1854. Synops. Ech. foss., *Pl. XIII. f. 3.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 505.
" " BÖLSCHE, 1865. Wieg. Arch., I. p. 327.
" " ! MART. 1866. Wieg. Arch., I. p. 155.
" " PERRIER, 1869. Pédic., p. 135, *Pl. IV. f. 2b.*
" **antillarum** PHIL. 1845. Wieg. Arch., I. p. 355. Cuba.
" *antillarum* ! A. AGASS. 1863. Bull. M. C. Z., I. p. 19. Florida.
" " ! LÜTK. 1864. Bid., p. 83.
" **tenuispina** PHIL. 1845. Wieg. Arch., I. p. 354. Sicily.
" *tenuispina* BÖLSCHE, 1865. Wieg. Arch., I. p. 325.
" **Lamarckii** ! ROUSSEAU, 1846. AG. DES., C. R. Ann. Sc. Nat., VI. p. 350. Zanzibar.
" *Lamarckii* BÖLSCHE, 1865. Wieg. Arch., I. p. 327.
" **paucispinum** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 19. Sandwich Islands.
" *paucispinum* BÖLSCHE, 1865. Wieg. Arch., I. p. 328.
" **globulosum** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 20. Kingsmills, Society Islands.
" *globulosum* BÖLSCHE, 1865. Wieg. Arch., I. p. 328.
" **nudum** A. AGASS. 1863. Proc. A. N. S. Phila., p. 353. Hong Kong.
" *nudum* BÖLSCHE, 1865. Wieg. Arch., p. 328.
" STEWART, 1865. Trans. Lin. Soc., XXV. *Pl. XLIII. f. 18a.*
" Enc. Méth., *Pl. CXXXIII. f. 10.*
" **pseudosavignyi** MICH. MS. (Écol. Min.).

Calmarius annellata GRAY, MS. (Brit. Mus.).

*Tortugas (Agassiz, Woodbury); *off Tortugas, 17 fms. (Pourtalès); *Cape Florida, (Wurdemann); *Cienfuegos (Aviles); Matanzas (Philippi); *Cuba (Arango); *Jeremie, Hayti (Weinland); *Salt Key, Florida (Pourtalès); *Bahamas (Dr. Bryant); *off Bahamas, Santarem Chan., 40 fms. (Pourtalès); *Bermudas; Martinique! (J. d. P.); Aspinwall! (Smithson. Coll.); Surinam! (Mus. Copenh.); Madeira! (Stimpson, Smithson. Coll.); *Lanzerote, Canary Islands (Haeckel); Cape Verde Islands! (Bouvier, J. d. P.); *Red Sea; *Tor, Red Sea (Frauenfeld); *Arabian Gulf (Millet); *Zanzibar (Cook, Cheney); Seychelles! Bombay! Madagascar! (J. d. P.); Nikobar! Amboina! (Mus. Copenh.); Simon's Bay, Cape of Good Hope! (Essex Inst.); Timor, Molucca (Martens); Reef of Attago! (Brit. Mus.); *Sandwich Islands (Garrett); Feejee Islands! (Mus. Godeff.); *Hong Kong (Stimpson); *Sunda Straits (Couthouy); Ousima! (Stimpson, Smithson. Coll.); Philippine Islands! (Semper); *Society Islands, *Kingsmills Islands (Garrett).

(CIDARIS.) DOROCIDARIS.

Echinus LINN. 1758. Syst. Nat. (pars.)
Cidaris LESKE, 1778. KL. Add. (pars.)
Cidarites LAMK. 1816. An. s. Vert. (pars.)
Phyllacanthus BRANDT, 1835. Prod. (pars.)
Leiocidaris DUJ. HUPÉ, 1862. Échin. (pars.)
Orthocidaris (**A. Agass.**) 1863. Bull. M. C. Z., I. p. 17 (non COTTEAU).
Dorocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Dorocidaris papillata

...... GUALTERI, 1742. Index, *Pl. CVIII. f. D.*
Cidaris **papillata** LESKE, 1778. KL. Ech., p. 61, *Pl. XXXIX. f. 2*, copied Enc. M., *Pl. CXXXVI. f. 6, 7.*
" *papillata* FLEM. 1828. Brit. An., p. 477.
" " !? FORBES, 1841. Brit. Starf., p. 146, fig. Scotland
" " ! DÜB. o. KOR. 1844. Skand. Ech., p. 255, *Pl. IX. f. 25–34.*
" " PHIL. 1845. Wieg. Arch., I. p. 353.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 326.
" " ! GRAY, 1848. Brit. Rad., p. 2.
" " ! SARS, 1861. Norges Echin. W. coast Norway.
Cidarites " DESML. 1837. Syn., p. 320.
Leiocidaris " ! DUJ. HUPÉ, 1862. Échin., p. 485.
" " ! PERRIER, 1869. Pédic, p. 129.
Orthocidaris papillata ! A. AGASS. 1863. Bull. M. C. Z., I. p. 17.
Dorocidaris " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 253.
Cidarites **hystrix** ! LAMK. 1816. An. s. Vert., p. 55. Mediterranean.
" *hystrix* DESML. 1837. Syn., p. 320.
Cidaris " ! BLAINV. 1834. Actinol., p. 231, *Pl. XX^{bis} f. 5.*
" " SARS, 1835. Beskriv., p. 40.
" " ! AGASS. 1836. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 326.
" " PHIL. 1845. Wieg. Arch., I. p. 353.
" " ARADAS, 1853. Atti. Gioen., VIII. p. 162. Sicily.
" " SARS, 1861. Middelh. Litt. Fauna, p. 109. Naples.
Phyllacanthus *hystrix* BRANDT, 1835 Prod., p. 268.
Leiocidaris " ! DUJ, HUPÉ, 1862. Échin., p. 484.
" " ! PERRIER, 1869. Pédic, p. 129, *Pl. III. f. 11.*
Orthocidaris " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 17. Nice.
Dorocidaris " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 253.
Cidaris **borealis** ! DÜB. o. KOR. 1844. Ak. Stork., p. 114. W. coast Norway.
" **affinis** PHIL. 1845. Wieg. Archiv., I. p. 351. Sicily.
" *affinis* SARS, 1857. Middelh. Litt. Fauna, p. 109. Naples.
Leiocidaris affinis DUJ. HUPÉ, 1862. Échin., p. 485.
Orthocidaris affinis ! A. AGASS. 1863. Bull. M. C. Z., I. p. 17.
Dorocidaris " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 253.
Cidaris **Stokesii** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 326. Mediterranean.
Leiocidaris Stokesii ! DUJ. HUPÉ 1862. Échin., p. 485.
" " ! PERRIER, 1869. Pédic, p. 131, *Pl. III. f. 6 a, b, c.*
Dorocidaris abyssicola ! A. AGASS. 1869. Bull. M. C. Z., I. p. 253. Straits of Florida.

*W. coast Norway (M. Sars); *Fishing Bk., Storeggen, 80–100 fms. (G. O. Sars); Bergen! (J. d. P.); *North Sea, 200 fms. (Mus. Stockholm); *Shetland Islands! (Liverpool Mus.); *Cape Wrath! 280 fms., *Cape Sagras, 165 fms., *So. Ireland, 80–90 fms. (Porcup. Exp.); *Mediterranean; *Nice (Verany); *W. coast Italy (Rigacci); *Naples (Panceri); Adriatic (Müller); Lessina, Lissa (Heller); *Carysfort Reef, 40–60 fms., Conch Reef, 40 fms., *Florida Gulf Stream, 195 fms., *French Reef, Florida, 45 fms., *Key West, 135 fms., off Tortugas, 60 fms., *Tennessee Reef, 114 fms., *Alligator Reef, 114 fms., *Sundry Stations, Florida Gulf Stream, 98, 116, 125, 152, 154 fms. (Pourtalès); Guadeloupe! (Duchassaing, J. d. P.).

ECHINANTHUS.

Echinanthus BREYN. 1732. Schedias. (pars.)
Echinus LIN. 1758. Syst. Nat. (pars.)
Echinanthus LESKE, 1778. KL. Add. (pars.)
" GRAY, 1825. Ann. Phil. (pars.)
Clypeaster LAMK. 1801. An. s. Vert. (pars.)
Clypeaster AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 129. (pars.)
Echinanthus GRAY, 1851. Proc. Zoöl. Soc. Lond. (pars.)
Clypeaster MÜLL. 1854. Bau d. Echin.
Echinanthus GRAY, 1855. Cat. R. Echin. (pars.)

Echinanthus rosaceus

...... SLOANE, 1725. Jam., *Pl. CCXLII. f. 6 – 11.*
...... SEBA, 1758. Thes., III. *Pl. XI. f. 2, 3, 13, 14.*
Scutum *angulare humile* ! KLEIN, 1734. *Pl. XVII. f. A*, *Pl. XVIII. f. B*, copied, E. M., *Pl. CXLV. f. 5, 6.*
...... KNORR, 1771. Délic., *Pl. DI. f. 12.*
...... Enc. Méth., *Pl. CXLIV. f. 7, 8.*
Echinus **reticulatus** LINN. 1758. Syst. Nat., p. 666. (pars).
Echinus reticulatus GMEL. 1788. LIN. Syst. Nat., 3191. (pars).
" **rosaceus** LINN. 1758. Syst. Nat.
Clypeaster *rosaceus* ! LAMK. 1801. An. s. Vert., p. 349.
Clypeaster " ! LAMK. 1816. An. s. Vert., p. 14. Ocean Indian ? N. American.
" " ! BLAINV. 1834. Actinol., p. 216, *Pl. XVII. f. 1, 2.*
" " ! AGASS. 1836. Prod., p. 187.
" " DESML. 1837. Syn., p. 212.
" " ! EDW. in Cuv. Règ. An. Ed. Ill., *Pl. XVI. f. 1.*
" " ! AGASS. DES. 1847. C. R. Ann. Sc. Nat., VII. p. 129. West Indies.
" " MÜLL. 1854. Bau d. Ech., *Pl. IV. f. 1, 3 – 5 ; Pl. V. f. 5 – 9.*
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 14, 16, 17.*
" " ! MICH. 1861. Clyp. Monog., *Pl. XIII.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 571, *Pl. X. f. 1 – 8.*
" " ! A. AGASS. 1863. Bull. M. C. Z., p. 25. Florida.
" " ! LÜTK. 1864. Bid., p. 100.
Echinanthus **humile** ! LESKE, 1778. *Pl. XVII. f. A ; Pl. XVIII. f. B.*
" *rosaceus* ! GRAY, 1825. Ann. Phil., p. 5.
" " GRAY, 1855. Cat. Rec. Echin., p. 4. West Indies.
Clypeaster **incurvatus** DESML. 1837. Syn., p. 212.
" **parvus** ! DUCH. 1847. Bull. Soc. Géol. fr., IV. 1093. Guadeloupe.
" *parvus* ! AGASS. DES. 1847. C. R. Ann. Sc. Nat., VII. p. 130.
" " DUJ. HUPÉ, 1862. Échin., p. 572.
Echinanthus parvus ! GRAY, 1855. Cat. R. Echin., p. 8.
Clypeaster **albolineatus** ! MICH. MS. (École. Min.)

*Charleston, S. C. (Allansen) ; *Tortugas (Holder, Agassiz) ; *Key West (Pourtalès) ; *Jeremie, Hayti (Weinland) ; *Jamaica (Adams) ; *Nassau (Shaw) ; *Bahamas (Bryant) ; Cuba ! (Arango) ; Guadeloupe ! (École. Min.).

Echinanthus testudinarius

Echinanthus **testudinarius** ! GRAY, 1851. Proc. Zoöl. Soc. Lond., p. 35.
" *testudinarius* ! GRAY, 1855. Cat. Echin., p. 6, *Pl I. f. 1.* Borneo ?
Clypeaster " ! MART. 1866. Wieg. Arch., I. p. 170. Timor.
" " ! VERRILL, 1871. Notes Rad., p. 588, *Pl. X. f. 7.*
Echinanthus **Australasiae** ! GRAY, 1851. Proc. Zoöl. Soc. Lond., p. 34. Australia.
" *Australasiae* ! GRAY, 1855. Cat. R. Ech., p. 5, *Pl. I. f. 2.*
Clypeaster **tumidulus** ! MÜLL. 1854. Bau d. Ech., p. 90.

Echinanthus testudinarius (*continued*).

Clypeaster **speciosus** ! Verrill, 1870. Sill. Journ., p. 95. La Paz.
" **Desorii** ! Mich. MS. (Écol. Min.).
" **Australiae** ! Mich. MS. (Écol. Min.).

*Hakodadi (Dall, Smithson. Coll.) ; *New Holland (Écol. Min.) ; Red Sea ! (J. d. P.) ; Japan ! (Bonn Mus.) ; Australia ! (Brit. Mus.) ; Sandwich Islands ! (Breslau Mus.) ; *La Paz (Pedersen, Yale Coll.).

(SCUTELLA.) Echinarachnius.

Scutella Lamk. 1816. An. s. V. (pars.)
Echinarachnius Gray, 1825. Ann. Phil. (non Leske).
Echinodiscus Blainv. 1834. Actinol. (pars.)
Echinarachnius Agass. 1841. Mon. Scut.
Dendraster Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 315.
Scaphechinus Barn. 1863. In A. Ag. Proc. A. N. S. Phila.
Chaetodiscus Lütk. 1864. Bid. till Kunds. om Echin.

Echinarachnius excentricus

Scutella **excentrica** Esch. 1829. Zoöl. Atl., *Pl. XX. f. 2.* Kamtchatka.
Echinarachnius excentricus ! Val. 1846. Voyage Vénus, Zooph., *Pl. X.*
Dendraster " ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 135. California.
Dendraster " ! Gray, 1855. Cat. Rec. Ech., p. 16.
" " ! Stimps. 1857. Crust. Ech., Pacific Sh., p. 87.
" " ! Duj. Hupé, 1862. Échin., p. 564.
Scutella striatula ! Conrad, 1856. Pacif. R. R. Survey, VII. p. 196, *Pl. IX. f. 1 a, b* (non M. de Serres).

*Monterey (Trowbridge) ; *San Francisco (A. Agassiz, Cary) ; *Puget Sound (Kennerly), Smithson. Coll.) ; Sitka, Unalach, Kamtchatka (Eschscholtz).

Echinarachnius mirabilis

Scaphechinus mirabilis ! Barn. 1863. In A. Ag. Proc. A. N. S. Phila , p. 359. Hakodadi.
Scaphechinus mirabilis ! Verrill, 1869. Proc. Bost. S. N. H., p. 384.
Chaetodiscus scutella ! Lütk. 1864. Bid., p. 104., *Pl. II. f. 11.*
Scutella **japonica** ! Mart. 1865. Monatsb. Berl. Ak., p. 140, March. Yedo.
Scutella japonica ! Mart. 1866. Wieg. Archiv., I. p. 138.

*Hakodadi (W. Stimpson, Dall, Smithson. Coll.) ; *Japan (Salmin) ; Yokohama ! (Mus. Berlin, Smithson. Coll.) ; Yedo, Kanagawa (Martens).

Echinarachnius parma

Scutella parma ! Lamk. 1816. An. s. Vert., p. 11.
Scutella parma Blainv. 1827. D. S. N. Scut., p. 226.
" " Desml. 1837. Syn., p. 230.
Echinodiscus parma Blainv. 1834. Actin., p. 218.
Echinarachnius parma ! Gray, 1825. Ann. Phil., p. 6.
" " ! Agass. 1836. Prod., p. 188.
" " ! Agass. 1841. Mon. Scut., p. 89, *Pl. XX. f. 9–18.* Canada.
" " ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 133.
" " ! Gray, 1855. Cat. Rec. Ech., p. 15. Atlantic Ocean.
" " ! Mich. 1859. Rev. Mag. Zoöl., No. 9.
" " ! Duj. Hupé, 1862. Échin., p. 562, *Pl. X. f. 13–17.*
" " ! A. Agass. 1863. Bull. M. C. Z., I. p. 26. New England.
" " ! A. Agass. 1865. Seaside Stud., figs. 130–140. Mass. Bay.
" " ! Verrill, 1866. Proc. Boston Soc. N. H., p. 340, 351.

Echinarachnius parma (*continued*).

Scutella **trifaria** SAY, 1826. Jour. Ac. N. S. Phila., p. 227.
" **Rumphii** ! BLAINV. 1827. Dict. Sc. Nat. Scut., p. 226.
Echinodiscus Rumphii ! BLAINV. 1834. Actin., p. 218.
Echinarachnius " ! AGASS. 1836. Prod., p. 188.
" " ! AGASS. 1841. Mon. Scut., p. 91, *Pl. XXI. f. 1–6.* Amboina ?
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 135.
" " ! GRAY, 1855. Cat. Rec. Ech , p. 15. Indian Ocean.
" " ! MICH. 1859. Rev. Mag. Zoöl., No. 9.
" " ! DUJ. HUPÉ, 1862. Échin., p. 562.
" **Atlanticus** ! GRAY, 1841. In AGASS. Mon. Scut., p. 92, *Pl. XXI. f. 32–34.* Newfoundland.
" *Atlanticus* ! STIMPS. 1853. Invert. Grand Menan, p. 16.
" " ! MICH. 1859. Rev. Mag. Zoöl., No. 9.
" " ! DUJ. HUPÉ, 1862. Échin., p. 562.
" **Asiaticus** ! MICH. 1859. Rev. Mag. Zoöl., No. 9, *Pl. XIII f. 3.* Kamtchatka.
" *Asiaticus* ! A. AGASS. 1863. Prod. A. N. S., Phila., p. 359. Avatscha Bay.
" " ! DUJ. HUPÉ, 1862. Échin., p. 563.
" " ! VERRILL, 1869. Proc. Boston Soc. N. H., p. 384. Aleutian Islands.
" **Australiae** ! MICH. 1859. Rev. Mag. Zoöl., No. 9, *Pl. XIII. f. 2.* Australia.
" *Australiae* ! DUJ. HUPÉ, 1862 Échin., p. 563.
" **undulatus** ! MICH. 1859. Rev. Mag. Zoöl., No. 9, *Pl. XIII. f. 1.*
" *undulatus* ! DUJ. HUPÉ, 1862. Échin., p. 563.

Long Island Sound! (Verrill); *New Jersey (Gedney, Smithson. Coll.); *Gay Head, *Nantucket, *South Shoals, Mass. (Agassiz); *Cape Cod (Atwood); *Mass. Bay (Agassiz); *St. George's Bank (Atwood); *Trenton Pt., Me. (Verrill, Shaler, Hyatt); *Eastport (Verrill); *Grand Menan (Mills); Gaspé (Dawson); Long Island (Say); Labrador! (Brit. Mus.); Mingan Islands! 2–15 fms., Straits Belle Isle! (Packard); *Avatscha Bay, *Kamtchatka, 30–70 fms. (W. Stimpson); *E. Vancouver Island; Aleutian Islands! (Smithson. Coll.); New Holland! (J. d. P., Écol. Min.); Indian Ocean! (Bonn Coll.); Red Sea! (Écol. Min.); India! (Brit. Mus.).

ECHINOBRISSUS.

Echinobrissus BREYN. 1732. Schedias. (pars.)
Echinobrissus GRAY, 1825. Ann. Phil.
" D'ORBIG. 1854. Rev. Mag. Zoöl. (pars.)
Nucleolites LAM. 1801. Syst. a. s. V. (pars.)

Echinobrissus recens

Nucleolites **recens** ! EDW. 1836, in CUV. Règ. An. Ed. Ill , *Pl. XIV. f. 3.*
" " AGASS. 1849. C. R. Ann. Sc. Nat., VII. p. 153. New Holland.
Echinobrissus recens D'ORBIG. 1854. Rev. Mag. Zoöl., p. 24.
" " DESOR, 1857. Échin. foss., p. 257.
" " ! DUJ. HUPÉ, 1862. Échin., p. 578, *Pl. X. f. 9, 10.*

Madagascar! New Zealand! (Brit. Mus.); Mers Australes! (J. d. P.); *M. C. Z.

ECHINOCARDIUM.

Echinospatagus BREYN. 1732. Sched. (pars.)
Spatagus MÜLL. 1776. Zool. Dan. Prod. (pars.)
Echinocardium GRAY, 1825. Ann. Phil. (pars.)
Amphidetus AGASS. 1836. Prodromus.
Amphidetus AGASS. 1847. C. R. Ann. Sc. Nat., VIII.
Amphidotus FORBES, 1841. Brit Starf.
Echinocardium GRAY, 1855. Cat. Rec. Ech.

Echinocardium australe

Echinocardium **australe** ! GRAY, 1851. Ann. Mag. N. H., p. 131. Australia.
" *australe* ! GRAY, 1855. Cat. R. Ech., p. 44, *Pl. IV. f. 1.* Van Diemen.
" " ! DUJ. HUPÉ, 1862. Échin., p. 602.
" **Zealandicum** ! GRAY, 1851. Ann. Mag. N. H., p. 131. New Zealand.
" *Zelandicum* ! GRAY, 1855. Cat. R. Ech., p. 44.
" " ! DUJ. HUPÉ, 1862. Échin., p. 602.
" **Stimpsoni** ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 360. Cape Good Hope.
Amphidetus **Novae Zelandiae** ! VAL. 1869. PERRIER, Péd., p. 176.

*New Zealand (J. d. P.) ; *Tshifu, China (Novarra Exp.) ; *Kagosima, Simon's Bay ! 12 fms. (W. Stimpson, Smithson. Coll.) ; *Mussell Bay (Mus. Godeff.) ; Van Diemen ! Port Jackson ! W. Australia ? (Brit. Mus.) ; So. Africa ! (Mus. Stutt.) ; Mozambique (Bianconi) ; China Seas ! East India ! (Mus. Copenh.).

Echinocardium cordatum

Echinus guineensis cordiformis SEBA, 1758. Thes., III., *Pl. X. f. 21.*
...... KNORR, 1771. Délic., *Pl. DI. f. 14.*
Echinospatagus *cordiformis* ...... BREYN. 1732. p. 61, *Pl. V. f. 5.*
Spatangus sp. 2, § 99, KLEIN, 1732. *Pl. XXIV. f. c, d, e.*
Echinus **cordatus** PENN. 1777. Brit. Zoöl., IV. p. 58, *Pl. XXXIV. f. 2; Pl. XXXVI. f. 2*, 2d ed. 1812.
Spatangus cordatus FLEM. 1828. Brit. An., p. 480 (non BLAINV.).
Amphidotus *cordatus* FORBES, 1841. Brit. Starf, p. 190, *f.* Scotland.
Amphidetus " ! DÜB. o. KOREN, 1844. Zool. Bid., p. 285. W. coast Norway.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 11, *Pl. XVI. f. 8.*
" " MÜLL. 1848. Achaeol., I. *Pl. III. Pl. IV. f. 6–8.* Pluteus.
" " MÜLL. 1854. Bau d. Ech., *Pl. III. f. 3–5.*
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 22.*
Echinocardium " ! GRAY, 1848. Brit. Rad., p. 6.
" *cordatum* ! GRAY, 1855. Cat. R. Ech., p. 43. North Sea.
" " ! DES. 1858. Syn. Ech. foss., *Pl. XLIII. f. 4, 5.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 602.
" " ! A. AGASS. 1863. Bull. M. C. Z., I.
Spatangus pusillus LESKE, 1778. KL. Add., p. 166, *Pl. XXIV. f. c, d, e* (non MÜLL.).
" " BLAINV. 1834. Actin., p. 201.
Echinocardium *pusillus* GRAY, 1825. Ann. Phil., p. 8.
Amphidetus *pusillus* AGASS. 1836. Prod., p. 184.
Spatangus flavescens ABILD. 1789. Zool. Dan., *Pl. XCI. f. 1–4* (non MÜLL. Prod.).
" *lacunosus* MÜLL. Zool. Dan. Text. (non LINN.).
Spatangus **arcuarius** ! LAMK. 1816. A. s. V., p. 32. Brit. Channel.
" *arcuarius* DESL. 1824. Enc. Méth., *Pl. CLVI. f. 7, 8.*
" " BLAINV. 1834. Actin., p. 201.
" " DESML. 1837. Syn., p. 378.

Echinocardium cordatum (*continued*).

Echinocardium Seba Gray, 1825. Ann. Phil, p. 8.
Amphidetus *Sebae* Agass. 1836. Prod., p. 184.
Amphidetus **Kurtzii**! Gir. 1852. Proc. Boston Soc. N. H., p. 213. So. Carolina.
Echinocardium Kurtzii! A. Agass. 1869. Bull. M. C. Z., I. No. Carolina.
? *Amphidetus* **ampliforus** M'Crady, 1857. Plioc. foss. So. Ca., p. 6, *Pl. II. f. 2.*
? " **gothicus** Raven. 1848. Echin. So. Ca.
? " *gothicus* M'Crady, 1857. Plioc. foss. So. Ca., p. 6, *Pl. II. f. 3.*

*Christianiafjord (G. O. Sars); *Kattegatt (Mus. Copenh.); *Irish Sea (Thos J. Moore); *Oban (W. Stimpson); *English Channel; *W. coast Italy (Rigacci); Finmark, Oresund (Sars); Drontheim — N. Cape, 15 fms. (McAndrew & Barrett); Shetland (Norman); Great Britain (Forbes); Scheveningen (Maitland); Bahia! (Mus. Godeff.); Charleston, S. Ca. (Agassiz); *off Tennessee Reef, Florida, 79 fms. (Pourtalès); *Beaufort, N. C. (Bickmore).

Echinocardium flavescens

Spatagus flavescens Müll. 1776. Prod., p. 235 (non Abild.).
Spatangus ovatus Flem. 1824. Wern. Mem., 484 (non Leske nec Lam.).
" " Flem. 1828. Brit. An, p. 40.
" " ! Blainv. 1834. Actin., p. 202.
" " Desml. 1837. Syn., p. 388.
Amphidetus ovatus! Düb. o. Kor. 1844. Skand. Ech., p. 283, *Pl. X. f. 50.* Norway.
" " ! Agass. 1847. C. R. Ann. Sc. Nat., VIII. p. 12.
" " ! Sars, 1861. Norges Ech, p. 98.
" " ! A. Agass. 1863. Bull. M. C. Z., I. p. 27.
" " ! Perrier, 1869. Pédic., p. 175, *Pl. VII. f. 2*, et No 193, p. 176.
Echinocardium ovatum! Gray, 1848. Brit Rad., p. 6.
" " ! Gray, 1855. Cat. R. Ech., p. 43. North Sea.
" " ! Duj. Hupé, 1862. Échin., p. 602.
" " ! A. Agass. 1869. Bull. M. C. Z., I. p. 276. Straits Florida.
Amphidotus roseus! ? Forbes, 1841. Brit. Starf. p. 194.

*Oresund (Eschricht); W. coast Norway (Sars); Lofoten Islands, 20, 30 fms. (G. O. Sars); *So. Ireland, *Cape Wrath, 100 fms. (Porcupine Exped.); Bergen, Finmark, Kattegatt (Sars); Drontheim — Cape North, 20 – 40 fms. (McAndrew & Barrett); Shetland Islands, Dublin, Belfast, Cornwall (Forbes); Shetland Islands (Norman); *Charleston, S. C. (Kurtz); *Florida Gulf Stream, 138 fms., *off Tennessee Reef, 85 – 115 fms. (Pourtalès).

Echinocardium mediterraneum

Amphidetus **mediterraneus**! ? Forbes, 1844. Journ. Lin. Soc. Lond. Ægean Sea.
" *mediterranneus*! ? Forbes, 1844. Ann. Mag. N. H., XIV. p. 413.
" " Agass. 1847. C. R. Ann. Sc. Nat., VIII. p. 12.
" *mediterranus* Sars, 1857. Middelh. Litt. Faun., p 117. Naples.
Echinocardium mediteraneum! Gray, 1855. Cat. R. Ech., p. 44.
" " Duj. Hupé, 1862. Éch., p. 602.
Amphidetus **gibbosus**! Agass. 1847. Ann Sc. Nat., VIII. p. 11. Algeria, Sicily.
Echinocardium gibbosum! Gray, 1855. Cat. R. Ech., p. 44.
" " ! Duj. Hupé, 1862. Échin., p. 602.

Amphidetus **sp.** Aradas, 1850. Atti. Gioen., VI. p. 80. Catania.

*Naples (Panceri); *Mediterranean; *Cette; *Bone, Algeria; Triest, Naples (Sars); Sicily (Gray); Genoa, Nice (Verany); Zara, Lessina, 2 – 20 fms. (Heller); Ægean Sea (Forbes).

Echinocardium pennatifidum

? *Echinocardium* **pennatifidum** NORM. 1868. 4th Rept. Dredging Shetland Islands, p. 440.
" *pennatifidum* HODGE, 1871. Trans. North. Durh., IV. *Pl. V.*
" **laevigaster** ! A. AGASS. 1869. Bull. M. C. Z., I. p. 277. Straits Florida.
? *Amphidotus gibbosus* **(Barrett,)** 1857. Ann. Mag. N. H., XIX. p. 32, *Pl. VII. f. 2* (non AGASS.).
? *Spatangus* **orthonotus** CONRAD, 1843. Proc. Phila. Ac. N. S., p. 327.
? *Amphidetus orthonotus* M'CRADY, 1857. Plioc. Foss. So. Ca., *Pl. II. f. 1.*
? *Echinocardium orthonotus* ! CONRAD, 1865. Proc. Ac. N. S. Phila.
? *Amphidetus* **virginianus** FORBES, 1849. Q. J. Geol. Soc. Lond., I. p. 425.

Northumberland (Hodge); *off Alligator Reef, 79 fms., *off Sombrero, 121 fms., *off Tennessee Reef, 114 fms. (Pourtalès); Shetland (Norman); Clyde District (Robertson).

ECHINOCYAMUS

Echinocyamus VAN PHEL. 1774. Brief.
Spatagus MÜLL. 1776. Prod. Zool. Dan. (pars.).
Echinus GMEL. 1788. LINN. Syst. Nat. (pars.).
Fibularia LAMK. 1816. A. s. Vert. (pars.)
Echinocyamus AGASS. 1841. Mon. Scut.
Scutellina AGASS. 1841. Mon. Scut.

Echinocyamus pusillus

Echinus **perexiguus** PETIV. 1764. Gaz., *Pl. XXXI. f. 10.*
...... KNORR, 1771. Délic., *Pl. DI. f. 10.*
Spatagus pusillus MÜLL. 1776. Prod., 2851. Zool. Dan., *Pl. XCI. f. 5, 6.*
Echinocyamus pusillus ! GRAY, 1825. Ann. Phil., p. 6.
" " FLEM. 1828. Brit. An., p. 481.
" " ! AGASS. 1841. Mon. Scut., p. 128, *Pl. XXVII. f. 1–8.* German Ocean.
" " ! ? FORBES, 1841. Brit. Starf., p. 175, fig.
" " PHIL. 1845. Wieg. Archiv, I. p. 356.
" " GRAY, 1848. Brit. Rad., p. 5.
" " MÜLL. 1853. Abhdl., I. *Pl. VII. f. 4;* Abhanl., VII. *Pl. VIII.* Pluteus.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 28. Atlantic Ocean, Mediterranean.
" " SARS, 1857. Middelh. Lit. Faun., p. 116.
" " DUJ. HUPÉ, 1862. Échin., p. 556.
" " PERRIER, 1869. Pédic, p. 167.
" **angulosus** LESKE, 1778. KL. Add., p. 215.
" *angulosus* ! AGASS. 1841. Mon. Scut., p. 130, *Pl. XXVII. f. 14–18.*
" " ! DÜB. o. KOREN, 1844. Skand. Ech., p. 279.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 140.
" " SARS, 1861. Norges Ech., p. 95.
" " ! DUJ. HUPÉ, 1862. Échin., p. 556.
" " ! PERRIER, 1869. Pédic, p. 167.
Fibularia angulosa DE FRANCE, 1820. D. S. N., XVI. p. 515.
" " DESML. 1837. Syn., p. 236.
Echinocyamus **vicia** LESKE, 1778. KL. Add.
" **ovalis** LESKE, 1778. KL. Add., p. 152, *Pl. XXXVII. f. 6.*
Echinus **pulvinulus** PENN. 1812. Brit. Zool., 2d ed., p. 140, *Pl. XXXVIII. f. 1–4.*
Echinocyamus minutus ! BLAINV.† 1834. Actin., p. 214.
Fibularia equina ARADAS, 1850. Monog. Ech., p. 203. Sicily.

† There is considerable doubt as to the authenticity of the specimens ascribed to LAMARCK and BLAINVILLE in the Jardin des Plantes.

Echinocyamus pusillus (*continued*).

Fibularia tarentina! LAMK. 1816. A. s. Vert., p. 17. Mediterranean.
Fibularia " DESLONG. 1824. Enc. Méth., II. p. 389.
" " RISSO, 1826. Europ. Mérid., V. p. 283.
" " DESML. 1837. Syn., p. 236.
" " BLAINV. 1834. Actin., p. 211, *Pl. XVI. f. 6.*
" " DUJ. HUPÉ, 1862 Échin., p. 557.
Echinocyamus tarentinus GRAY, 1825. Ann Phil., p. 6.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 140.
" " BRONN, 1859. Kl. u. Ord. Actin., p. 339, *Pl. XXXIX. f. 24; Pl. XLI. f. 13.*
" " PERRIER, 1869. Pédic, p. 167.
" **minimus**! GIR. 1850. Proc. Boston S. N. II.
" **parthenopaeus** COSTA, 1871. Echinoc. viv. e. foss.
" **speciosus** COSTA, 1871. Echinoc. viv. e. foss.

*W. coast Norway (Sars); *W. seas of Europe; Oban (W. Stimpson); *Lofoten Islands, 300 fms. (G. O. Sars); *W. coast Sweden (Mus. Stockh.); Oresund (Mus. Copenh.); Devon, Scotland, E. & W. coast Britain (Forbes); Drontheim — Cape North, 15 – 25 fms. (McAndrew & Barrett); Arran Berwick (Gray); Nord See (Maitland); N., E., S. Ireland (Thomson); Iceland (Steenstrup); Shetland (Norman); *Carysfort Reef, 117, 138 fms., *Bocca grande, 125 fms., *Sand Key, 100, 120, 325 fms., *off Alligator Reef, 147, 138, 110, 79 fms., *Conch Reef, 169, 139, 117 fms., *Key West, 138, 130, 125 fms., *Tennessee Reef, 183, 115, 114, 75 fms., *Salt Key, 5 fms. (Pourtalès); *Naples (Panceri); *Corsica (Cotteau); *Civita Vecchia (Rigacci); *Mediterranean; Adriatic (Müller); Nice (Risso); Genoa! (Verany); Palermo! Egypt! (J. d. P.); Lissa, Lessina, Ragusa, Adriatic (Heller); Lussin (Grube); *Fayal! (Higginson); Josephine Bk.! (Mus. Stockh.).

ECHINODISCUS.

Echinus RUMPH. 1705. Amb. Rar. Kam. (pars.)
Mellita KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinodiscus LESKE, 1778. KL. Add. (pars.)
Scutella LAMK. 1816. A. s. Vert. (pars.)
Echinodiscus GRAY, 1825. Ann. Phil. (pars.)
Lobophora (**Agass.**) 1841. Monog. Scut. (non CURT. 1825, nec SERVILLE, 1839).
Amphiope AGASS. 1840. Cat. Syst. Ectyp.
Amphiope AGASS. 1841. Monog. Scut.

Echinodiscus auritus

Echinus **planus** ...... RUMPH. 1705. *Pl. XIV. f. F*; copied ENC. MÉTH., *Pl. CLII.* Amboina. (pars.)
Echionanthus maximus ...... SEBA, 1758. Thes, III. *Pl. XV. f. 1–4*; copied ENC. MÉTH., *Pl. CLI. f. 5, 6.*
Echinodiscus **auritus** LESKE, 1778. KL. Add., p. 136.
" *auritus*! GRAY, 1825. Ann. Phil., p. 6.
Echinus auritus GMEL. 1788. LINN. Syst. Nat., 3189.
Scutella aurita! BLAINV. 1834. Actin., p. 220.
" " ! AGASS. 1836. Prod., p. 188.
Lobophora aurita! AGASS. 1841. Mon. Scut., p. 70, *Pl. XIII. f. 1; Pl. XIV. f. 3–7.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 136.
" " ! DUJ. HUPÉ, 1862. Échin., p. 565.
Echinodiscus **inauritus** LESKE, 1778. KL. Add., p. 38.
" *inauritus*! GRAY, 1825. Ann. Phil., p. 6.
" *inaurita*! GRAY, 1855. Cat. Rec. Ech., p. 21.
Echinus inauritus GMEL. 1788. LINN. Syst. Nat., 3190.

Echinodiscus auritus (*continued*).

Scutella inaurita ! BLAINV. 1834. Actin., p. 220.
" " ! AGASS. 1836. Prod., p. 188.
...... ANDOUIN in SAVIGNY, Égypte Zooph. Éch., *Pl. VII. f. 3.* Red Sea.
Scutella bifissa ! LAMK. 1816. A. s. Vert., p. 10.
Scutella bifissa ! BLAINV. 1827. Scut. D. S. N., p. 224.
" " DESML. 1837. Syn., p. 226.
Lobophora bifissa ! AGASS. 1841. Mon. Scut., p. 67, *Pl. XIII. f. 2–6; Pl. XIV. f. 1, 2.* Zanzibar.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 8. Isle de France.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 136.
" " ! DUJ. HUPÉ, 1862. Échin., p. 565.
" " ! MART. 1866. Wieg. Arch., p. 177.
" **Dubusii** BELVAL, 1863. Bull. Ac. Brux., XVI. p. 198.
" **Agassizii** BELVAL, 1863. Bull. Ac. Brux., XVI. p. 198.

*Zanzibar (Ashby, Ropes, Cook); *Red Sea! (J. d. P.); Mozambique (Peters); Suez! Mauritius! India! (Brit. Mus.); Bourbon! (École. Min.); Amboina (Martens); Philippine Islands! (Semper).

Echinodiscus biforis

Mellita laevis KLEIN, 1734. Nat. Disp. Ech., *Pl. XXI. f. A, B.* (pars.)
...... KNORR, 1771. Délic., *Pl. DI. f. 15.*
Echinodiscus **bisperforatus** LESKE, 1778. KL. Add., p. 132, *Pl. XXI. f. A, B.*
Echinus **biforis** GMEL. 1788. LINN. Syst. Nat., 3188.
Lobophora biforis MART. 1866. Wieg. Arch., p. 177. Java.
Scutella *bifora* ! LAMK. 1816. An. s. Vert., p. 10 (non BLAINV. nec DESML.).
Scutella " AGASS. 1836. Prod., p. 188.
Echinodiscus bifora ! GRAY, 1825. Ann. Phil., p. 6.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 20.
Lobophora " ! AGASS. 1841. Mon. Scut., p. 64, *Pl. XII.* Madagascar.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 136.
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 3'.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 565.
Scutella **bilinearifora** DESML. 1837. Syn., p. 226.
Lobophora **Desmoulinsii** MICH. MS. (École. Min.)

*Madagascar, *Mussell Bay, Cape Good Hope (Mus. Godeff.); Red Sea! (J. d. P.); Mozambique (Peters); Java (Martens).

Echinodiscus laevis

Mellita laevis ! KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinodiscus **bisperforatus** LESKE, 1778. KL. Add. (pars.)
Scutella bifora ! BLAINV. 1827. D. S. N. Scut., p. 223 (non LAMK.).
" *bifora* DESML. 1837. Syn., p. 226.
" *biforis* ! BLAINV. 1834. Actin., p. 219.
Lobophora **truncata** ! AGASS. 1841. Mon. Scut., p. 66, *Pl. XI. f. 11–16.*
" *truncata* ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 136.
" " ! DUJ. HUPÉ, 1862. Échin., p. 565.
Echinodiscus " ! GRAY, 1855. Cat. Rec. Ech., p. 20.
Lobophora **tenuissima** ! VAL. 1847. AGASS. C. R. Ann. Sc. Nat., VII. p. 136. Waigiou.
" *tenuissima* BELVAL, 1863. Bull. Ac. Brux., XVI. p. 198.
Echinodiscus tenuissima ! GRAY, 1855. Cat. Rec. Ech., p. 20.
Lobophora **Deplanchei** ! MICH. 1861. Rev. Mag. Zoöl., p. 327, *Pl. IX. f. 1.* New Caledonia.
" **texta** ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 359. Japan.

*Ousima (W. Stimpson, Smithson. Coll.); *New Caledonia (Crosse); Tanegasima! China Seas, Lat. 23° N., 20 fms.! (W. Stimpson, Smithson. Coll.); Linguin, China Seas (Liverpool. Mus.); So. Africa! (Mus. Godeff.); Penang! (Mus. Copenh.); Waigiou! (J. d. P.); Burmah! (Nat. Hist. Soc. Bost.).

ECHINOLAMPAS.

Echinanthus BREYN. 1732. Schedias. (pars.)
Scutum KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinanthus LESKE, 1778. KL. Addit. (pars.)
Echinus GMEL. 1788. LINN. Syst. Nat., 3187. (pars.)
Nucleolites LAMK. 1801. An. s. Vert. (pars.)
Clypeaster LAMK. 1816. An. s. Vert. (pars.)
Echinolampas GRAY, 1825. Ann. Phil.
Echinolampas AGASS. 1847. C. R. Ann. Sc. Nat., VII.
Echinanthus D'ORBIGNY, 1854. Rev. Mag. Zoöl.

Echinolampas depressa

Echinolampas **depressus** ! GRAY, 1851. Ann. Mag. N. H., p. 38.
" *depressus* ! GRAY, 1855. Cat. Rec. Ech., p. 36, *Pl. II. f. 4.*
" **caratomoides** ! A. AGASS. 1869. Bull. M. C. Z., I. p. 269. Straits of Florida.

*Off Tortugas, 35, 68 fms., *off Carysfort Reef, 40, 60, 98, 320 fms., *off Conch Reef, 77 fms. (Pourtalès).

Echinolampas Hellei

Echinolampas Richardi (**Desml.**) 1837. Tab. Syn., p. 340 (non DESMT.). Senegal.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 163.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 36.
Echinanthus Richardi ! D'ORB. 1854. Rev. Mag. Zoöl., p. 21.
Echinolampas Laurillardi ! DESML. 1847. C. R. Ann. Sc. Nat., VIII. (non AGASS.). Note of Jules Marcou.
" **Hellei** ! VAL. 1869. PERRIER, Pédic., p. 170.
" **Rangii** DESML. 1870. Act. Soc. Lin. Bordeaux, XXVII. *Pl. XX.*

*Cape Palmas (Dr. Perkins, Essex Inst.); Senegal! mouth of Rio Grande (J. d. P.).

Echinolampas oviformis

Echinus sulcatus ...... RUMPH. 1705. Amb. Rar. Kam., *Pl. XIV. f. 3.*
Scutum ovatum KLEIN, 1734. Nat. Disp. Ech., § 78, *Pl. XX. f. c, d.*
Echinanthus ovatus LESKE, 1778. KL. Add., p. 127, *Pl. XX. f. c, d.*
Echinus **oviformis** GMEL. 1788. LINN. Syst. Nat., 3187.
Nucleolites *oviformis* ! LAMK. 1801. An. s. Vert., p. 347.
Clypeaster " ! LAMK. 1816. An. s. Vert., p. 15.
" " ! BLAINV. 1825. D. S. N., p. 190.
Echinolampas *oviformis* ! GRAY, 1825. Ann. Phil., p. 7.
Echinolampas " ! BLAINV. 1834. Actin., p. 209.
" " DESML. 1837. Syn., p. 340.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 163.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 35. Red Sea.
" " ! MART. 1866. Wieg. Archiv, I. p. 178. Molucca.
" " ! PERRIER, 1869. Pédic., p. 170.
Echinanthus oviformis D'ORB. 1854. Rev. Mag. Zoöl.
Echinus orientalis ...... SEBA, 1758. Thes., III. *Pl. X. f. 23 a, b,* copied in Enc. Méth., *Pl. CXLIV. f. 1, 2.*
Echinolampas orientalis ! GRAY, 1825. Ann. Phil.
Echinolampas orientalis BLAINV. 1834. Actin., p. 209, *Pl. XVI. f. 2.*
" " ! AGASS. 1836. Prod., p. 20.
" " DESML. 1837. Syn., p. 340.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 163.

Echinolampas oviformis (*continued*).

Echinolampas orientalis GRAY, 1855. Cat. Rec. Ech., p. 36.
Echinanthus " D'ORB. 1854. Rev. Mag. Zool.
Echinolampas **cyclostomus** ! PERRIER, 1869. Pédic., p 170.
" **Bottae.** MS. (J. d. P.).

*Mauritius (Pike); Red Sea (J. d. P.); Tranquebar! Cape Good Hope! (Mus. Copenh.); Molucca (Martens); Ceylon! (Brit. Mus.).

ECHINOMETRA.

Echinometra RONDEL. 1554. De Piscib. Mar. (BREYN.)
Cidaris KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinus LINN. 1758. (pars.)
Echinometra GRAY, 1825. Ann. Phil.
Echinometra AGASS. 1846. C. R. Ann. Sc. Nat., VI.
Heliocidaris AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Ellipsechinus LÜTK. 1864. Bid. til ...... Echin.

Echinometra lucunter

...... GUALTERI, 1742. *Pl. CVII. f. c.*
Cidaris *variolata ellyptica*, 1, variol. freq.! KLEIN, 1734. Nat. D. Ech., *Pl. IV. f. C, D.*
" " " *β*. 2, variol. rarior.! KLEIN, 1734. Nat. Disp. Ech., *Pl. V. f. b, c.*
Cidaris lucunter LESKE, 1778. Kl. Add., *Pl. IV. f. C, D.*
Echinus " ! LAMK. 1816. An. s. Vert., p. 50 (non LINN. nec LUTK.). Inde. Isle de France.
" " ! BLAINV. 1825. Dict. Sc. Nat. O., p. 93.
Echinometra lucunter ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 260.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 10. Isle de France.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 372. Timor Straits. Philippine Islands. Cochin China.
" " ! DUJ. HUPÉ, 1862. Échin., p. 538.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Sandwich Islands. Society Islands.
" " ! A. AGASS. 1863. Proc. Acad. N. S. Phila., p. 355. Ousima.
" " ! MART. 1866. Wieg. Arch., I. p. 164. Sumatra. Molucca. Amboina. Flores.
Echinus **Mathaei** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 93.
Echinometra Mathaei ! BLAINV. 1834. Actin., p. 225 (non AGASS.).
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 260.
" " ! GRUBE, 1857. Nov. Act., XXVII. p. 44.
" " ! DUJ. HUPÉ, 1862. Échin., p. 538.
" **heteropora** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 372. Zanzibar.
" *heteropora* ! DUJ. HUPÉ, 1862. Échin., p. 538.
" " ! PERRIER, 1869. Pédic., p. 161., *Pl. XVI. f. a, b.*
" **brunea** ! A. AGASS. 1863. P. A. N. S. Phila., p. 355. Bonin.
" *acufera* ! A. AGASS. 1863. Bull. M. C. Z., I. (non BLAINV.). Zanzibar.
" **microtuberculata** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 22. Kingsmills Islands. Sandwich Islands

*Zanzibar (Ropes, Cheney, Cook); *Mozambique (Cook); *Tor, Red Sea (Mus. Vienna); Madagascar (Liverpool Mus.); *Mauritius (Pike); Natal! (Mus. Stutt.); Philippine Islands! (Semper); Feejee Islands! Upolu! (Mus. Godeff.); Bourbon! (École. Min.); Cape Good Hope! (Smithson. Coll., Stimpson); *Society Islands, *Sandwich Islands, *Kingsmills Islands (Garrett); *Bonin, *Loo Choo Islands (Stimpson, Smithson. Coll.); New Caledonia! (Crosse); Samoa! Java! (Acad. N. S. Phila.); *Calcutta (Theobald); Seychelles! Cochin China! Samar! Straits Torres, Solomon Islands (J. d. P.); Arabian Gulf! Japan, Sumatra, Timor, Molucca, Flores, Adenare, Buru (Martens).

Echinometra macrostoma

Ellipsechinus macrostomus LÜTK. 1864. Bid., p. 165, *Pl. I. f. 10.*

Echinometra oblonga

Echinus **oblongus** ! BLAINV. 1825. Dict. Sc. N. O., p. 95.
Echinometra oblonga ! BLAINV. 1834. Actin., p. 225. Seychelles.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 260. (pars.)
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Sandwich Islands.
" *Mathaei* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 373 (non BLAINV.).

*Sandwich Islands, *Kingsmills Islands (Garrett); Zanzibar! Solomon Islands! Waigiou! Seychelles! (J. d. P.); Philippine Islands! (Semper); Nikobar! (Mus. Vienna); Mitchell's Islands! (Mus. Godeff.).

Echinometra subangularis

...... SLOANE, 1725. Jam., *Pl. CCXLIV. f. 1, 2, 3.*
...... SEBA, 1758. Thes., III. *Pl. X. f. 11, 16, 18; Pl. XI. f. 11.*
...... KNORR, 1771. Délic., *Pl. DI. f. 8; Pl. DIII. f. 6.*
Cidaris *variolata* ...... ! KLEIN, 1734. Nat. D. Ech., *Pl. III. f. C, D.*
" " ...... ! KLEIN, 1734. Nat. D. Ech., *Pl. IV. f. E, F.; Pl. XXX. A, B.*
? *Echinus* **lucunter** LINN. 1758. Syst. Nat., ed. X. p. 665 (non LAM.).
? " " GMEL. 1788. LINN. S. N., 3176.
Cidaris lucunter LESKE, 1778. KL. Add., p. 109, *Pl. IV. f. E, F*, copied in ENC. MÉTH., *Pl. CXXXIV.*
Echinometra lucunter ! GRAY, 1825. Ann. Phil., p. 4.
" " ! LÜTK. 1864. Bid., p. 87. W. Indies.
Cidaris **subangularis** ! LESKE, 1778. KL. Add.
" **fenestrata** LESKE, 1778. KL. Add. (pars.)
Echinometra subangularis DESML. 1837. Syn., p. 266.
Echinus **Maugei** ! BLAINV. 1825. D. S. Nat. O., p. 93.
Echinometra Maugei ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 260.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 373. (pars.)
" " ! DUJ. HUPÉ, 1862. Échin., p. 528.
Echinus **acufer** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 94.
Echinometra acufera ! BLAINV. 1834. Actin., p. 225 (non A. AGASS.).
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 260.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 373. (pars.)
" " ! DUJ. HUPÉ, 1862. Éch., p. 538.
" " ! MART. 1866. Wieg. Arch., I. p. 166.
Echinus **lobatus** ! BLAINV. 1825. Dict. Sc. N. O., p. 95.
Echinometra lobata ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 262.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 373.
" " ! DUJ. HUPÉ, 1862. Échin., p. 539.
" **Michelini** ! DES. 1846. AGASS. C. R. Ann. Sc. Nat., VI. p. 373 (non LÜTK.). Yucatan.
" *Michelini* ! A. AGASS. 1863. Bull. M. C. Z., I. Florida. W. Indies.
" " ! VERRILL, 1867. Notes Radiata, p. 369.
" **nigrina** ! GIR. 1850. Proc. Boston Sc. N. H., p. 367. Cape Palmas.
Heliocidaris **mexicana** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 372 (non T. *mex.* A. AG.).
" *mexicana* ! DUJ. HUPÉ, 1862. Échin., p. 537.

Echinometra subangularis (*continued*).

Heliocidaris **Castelnaudi**! HUPÉ, 1858. CASTELN. Voyage Am. Sud., p. 97, Zooph., *Pl. I. f. 1.* Brazil.
" *Castelnaudi*! DUJ. HUPÉ, 1862. Échin., p. 537.
Echinometra **complanata** MICH. MS. (École. Min.).

*Cape Palmas (Dr. Perkins, Essex Inst.); *Cape Verde Islands (Bouvier); *Florida (Agassiz); Ascension! (J. d. P.); *Rio Janeiro (Agassiz, Thayer Exp.); *Desterro (F. Müller); *Guarapary, *Porto Seguro, *Victoria, *Campos, *Isla de Mazecas (Hartt & Copeland, Thayer Exp.); *Cuba (Arango); *Tortugas (Pourtalès, Agassiz); Abrolhos! (Hartt); *St. Thomas (Agassiz, Thayer Exp.); *Hayti (Weinland); *Charleston, S. C. (Agassiz); *Sombrero Island (Knox); *Jamaica (Adams); Bermudas (Hammond); *Aspinwall; *Nassau (Shaw); *Cumana (Anthony); *Bahamas (Bryant).

Echinometra Van Brunti

Echinometra **Van Brunti**! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Acapulco.
" *Van Brunti*! VERRILL, 1867. Notes Radiata, p. 309. San Salvador. Peru.
" " ! VERRILL, 1871. Notes Radiata, p. 585.
" **rupicola**! A. AGASS. 1863. Bull. M. C. Z, I. p. 21. Panama.
" *rupicola*! VERRILL, 1867. Notes Radiata, p. 308.

*Acapulco (A. Agassiz); *Cape St. Lucas, *Manzanillo (Xanthus, Smithson. Coll.); *La Paz (Pedersen, Yale Coll.); *Panama (A. Agassiz); *San Juan del Sur (Silliman, Yale Coll.); *Pearl Islands (Bradley, Yale Coll.); *La Union (Yale Coll.); Zorritos! Nicaragua! (Yale Coll.).

Echinometra viridis

Echinometra **viridis**! A. AGASS. 1863. Bull. M. C. Z., I. p. 22. Florida.
" *viridis*! A. AGASS. 1869. Bull. M. C. Z, I. p. 261.
" **plana**! A. AGASS. 1863. Bull. M. C. Z., I. p. 22. Hayti.
" *Michelini*! LÜTK. 1864. Bid., p. 91, *Pl. I. f. 1* (non DES. nec A. AG.). W. Indies.

*Tortugas, Fla. (Agassiz, Pourtalès); *Key Biscayne (Lyman); Cuba! (Arango); *West Indies, *Jeremie, Hayti (Weinland).

ECHINONËUS.

Echinonëus VAN PHELS. 1774. Brief.
Echinus GMEL. 1788. Syst. Nat. (pars.)
Echinanaus GRAY, 1825. Ann. Phil.
Galerites DESML. 1837. Syn. (non AUCT.).

Echinonëus cyclostomus

...... SEBA, 1758. Thes., III. *Pl. XV. f. 30, 33, 34.*
Echinoneus **cyclostomus** LESKE, 1778. KL. Add., p. 173, *Pl. XXXVII. f. 4, 5,* copied ENC MÉTH., *Pl. CLIII. f. 19, 20.*
" *cyclostomus*! LAMK. 1816. An. s. Vert., p. 18. Asiatic Seas.
" " ! BLAINV. 1825. Dict. Sc. Nat., p. 196.
" " ! BLAINV. 1834. Actin., p. 212, *Pl. XVI. f. 5.*
" " ! AGASS. 1836. Prod., p. 187. Philippine Islands.
" " ! DESOR, 1842. AGASS. Mon. Éch. Galérites, p. 43, *Pl. VI. f. 13–15.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 143.
" " ! GRAY, 1855. Cat. Rec. Echin., p. 32. Australia.
" " DESOR, 1857. Syn. Echin. foss., *Pl. XXVII. f. 1–3.*

Echinoneus cyclostomus (*continued*).

Echinoneus cyclostomus ! DUJ. HUPÉ, 1862. Échin. p. 545.
Echinus " GMEL. 1788. LINN. Syst. Nat. 3183.
Echinanaus " ! GRAY, 1825. Ann. Phil., p. 7.
Galerites **echinonea** DESML. 1837. Syn., p. 246.
Echinoneus **cruciatus** ! AGASS. 1843. DES. Mon. Galérites, p. 46, *Pl. VI. f. 1–3.*
" *cruciatus* ! GRAY, 1855. Cat. Rec. Echin., p. 33.
" **serialis** ! DES. 1842. AG. Mon. Éch. Galérites, p. 48, *Pl. VI. f. 10–12.*
" *serialis* ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 143.
" " ! GRAY, 1855. Cat. Rec. Echin., p. 33.
" " ! DUJ. HUPÉ, 1862. Échin., p. 545.
" **crassus** ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 143. Zanzibar.
" *crassus* ! GRAY, 1855. Cat. Rec. Echin., p. 33.
" " ! DUJ. HUPÉ, 1862. Échin., p. 546.
" " ! MICH. 1862. MAILLD. Bourbon Annéx. A, *Pl. XVI. f. 1.*
" **ventricosus** ! AGASS. 1847. C. R. Ann. Sc. Nat., VI. p. 144. New Zealand ?
" *ventricosus* ! GRAY, 1855. Cat. Rec. Echin., p. 33.
" " ! DUJ. HUPÉ, 1862. Échin., p. 546.
" *minor* ! MART. 1866. Wieg. Arch., I. p. 169 (non AUCT.). Flores. Amboina. Manila.

*Australia ; *Bourbon (J. d. P.) ; *Kingsmills Islands (Garrett) ; Zanzibar ! (J. d. P.) ; Flores, Amboina, Manila (Martens) ; Lord Hood's Islands ! (Brit. Mus.).

Echinoneus semilunaris

...... SEBA, 1758. Thes., III. *Pl. X. f. 7,* copied in LESKE, *Pl. XLIX. f. 8, 9,* et ENC. MÉTH. *Pl. CLIII. f. 21, 22.*
...... KNORR, 1771. Délic., *Pl. DI. f. 11.*
Echinoneus **minor** LESKE, 1778. KL. Add., p. 174, *Pl. XLIX. f. 8, 9.*
" *minor* ! BLAINV. 1834. Actin., p. 212.
" " ! DESOR, 1842. AGASS. Mon. Éch. Galérites, *Pl. VI. f. 16.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII., p. 143.
" " ! GRAY, 1855. Cat. Rec. Echin., p. 32.
" " ! DUJ. HUPÉ, 1862. Échin., p. 545.
Echinus **ovalis** LINN. 1753. Mus. Tess., p. 114.
" **semilunaris** GMEL. 1788. LINN. Syst. Nat.
Echinoneus semilunaris ! LAMK. A. 1816. An. s. Vert , p. 19. St. Domingo. W. Indies.
" " ! BLAINV. 1825. Dict. Sc. Nat , XIV. p. 196.
" " ! BLAINV. 1834. Actin., p. 212.
" " ! AGASS. 1836. Prod., p. 20.
" " ! DESML. 1837. Syn., p. 340.
" " ! EDW. in CUV. Règ. An. ed. Ill., *Pl. XIV. f. 1.*
" " ! LÜTK. 1864. Bid., p. 124. W. Indies.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 267. Straits Florida.
" **gibbosus** ! LAMK. 1816. An. s. Vert., p. 19. American Seas.
" *gibbosus* ! BLAINV. 1825. Dict. S. N., XIV. p. 196.
" " ! AGASS. 1836. Prod., p. 20.
" " DESML. 1837. Syn., p. 340.
" " ! DES. 1842. AG. Mon. Éch. Galérites, p. 46, *Pl. VI. f. 4–6.*
" " ! GRAY, 1855. Cat. Rec. Ech., p. 32.
" **elegans** ! DESOR, 1842. AG. Mon. Éch. Galérites, p. 47, *Pl. VI. f. 7–9.* Hayti.
" *elegans* ! A. AGASS. 1863. Bull. M. C. Z., I. Florida.
" **conformis** ! DES. 1842. Mon. Gal., p. 48, *Pl. VI. f. 17–21.*
" *conformis* BRONN, 1859. Kl. u. Ord. Actin., *Pl. XLII. f. 2.*

*Jamaica, *St. Thomas (Adams) ; Jeremie, Hayti (Weinland) ; *Cuba ; *Bermuda (Hammond) ; *Carysfort Reef (Pourtalès) ; Guadeloupe ! (Brit. Mus.) ; Cuba ! Arango ; Porto Rico ! (Mus. Copenh.).

ECHINOSTREPHUS.

Echinometra ...... RUMPH. 1705. Amb. Rar. Kam.
Echinus BLAINV. 1825. Dict. Sc. Nat. (pars.)
Psammechinus DUJ. HUPÉ, 1862. Échin. (pars.)
Echinostrephus A. AGASS. 1863. Bull. M. C. Z., I.

Echinostrephus molare

Echinometra **setosa** RUMPH. 1705. Amb. Rar. Kam., *Pl. XIII. f. 5.*
...... SEBA, 1758. Thes., III. *Pl. XIII. f. 9.*
Echinus **molaris**! BLAINV. 1825. Dict. Sc. Nat. O., p. 88.
" *molaris* DESML. 1837. Syn., p. 282.
" **mola**! BLAINV. 1834. Actin., p. 228.
" **laganoides**! DES. 1846. AGASS. C R. Ann. Sc. Nat., VI. p. 370.
Psammechinus laganoides! DUJ. HUPÉ, 1862. Échin., p. 528.
" " ! PERRIER, 1869. Pédic., p. 151.
Echinus **lezaroides** PERRIER, 1869. Pédic., p. 146.
" **longispina**! BLAINV. 1825. Dict. Sc. Nat. O., p. 89.
" *longispinus*! BLAINV. 1834. Actin., p. 228.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 370.
" " ! PERRIER, 1869. Pédic., p. 146.
" *longispina* DESML. 1837. Syn., p. 282.
Psammechinus longispinus DUJ. HUPÉ, 1862. Échin., p. 527.
" " PERRIER, 1869. Pédic., p. 151.
Echinostrephus aciculatus! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Kingsmills Islands. Sandwich Islands.
Perinatus *laganoides* DES. MS. (J. d. P.).

*Kingsmills Islands, *Sandwich Islands, *Society Islands (Garrett); *Zanzibar (Cooke); Mozambique! (Mus. Stock.); Natal! (Mus. Stutt.); Bourbon! (J. d. P.); Cape Good Hope (Brit. Mus.); Amboina (Rumph.).

ECHINOTHRIX.

Echinometra ...... RUMPH. 1705. Amb. Rar. Kam.
Diadema SCHYNV. 1711. Thes. Imag.
Cidaris KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinus GMEL. 1788. LINN. Syst. Nat. (pars.)
Cidarites LAMK. 1816. An. s. Vert. (pars.)
Astropyga AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Echinothrix PETERS, 1853. Monatsb. Akad. Berlin.
Echinothrix BÖLSCHE, 1865. Wieg Archiv.
" A. AGASS. 1863. Bull. M. C. Z., I.
Savignya DES. 1854. Syn. Ech. foss.
Garelia GRAY, 1855. Proc. Zoöl. Soc. Lond.
Garelia A. AGASS. 1863. Bull. M. C. Z.

Echinothrix calamaris

Echinus **calamaris** PALL. 1774. Spic. Zool., I. fas. X. *Pl. II. f. 4–8,* copied in DESLONG. Enc. Méth., *Pl. CXXXIV. f. 9–11.*
Cidaris calamaris LESKE, 1778. KL. Ech., p. 115, *Pl. XLV. f. 1–4.*
Echinus calamarius GMEL. 1788. LINN. Syst. Nat., 3173.

Echinothrix calamaris (*continued*).

Cidarites **calamaria**! LAMK. 1816. A. s. Vert., p. 58. (pars.)
Diadema calamaria! GRAY, 1825. Ann. Phil., p. 4.
" *calamarium*! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 308.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 14.
" " ! DUJ. HUPÉ, 1862. Échin., p. 505. (pars.)
" *calamare*! MART. 1866. Wieg. Arch., p. 150. (pars.) Timor.
Cidaris calamaria! BLAINV. 1834. Actin., p. 231.
Astropyga calamaria! AGASS. 1846. C. R. Ann. Sc. Nat, VI. p. 345. Amboina.
Echinothrix *calamaria* PETERS, 1853. Monatsb. Berl. Ak., p. 484. Mozambique.
Echinothrix " ! PETERS, 1854. Seeig. v. Moss., p. 116.
" " ! PETERS, 1854. Seeig. v. Moss., p. 116.
Garelia aequalis! GRAY, 1855. Proc. Zoöl. Soc. Lond., p. 38. Mauritius.
Echinothrix aequalis! BOLSCHE, 1865. Wieg. Arch., I. p. 333.
" **aperta**! A. AGASS. 1863. Bull. M. C. Z., p. 19. Society Islands.
" *aperta*! BÖLSCHE, 1865. Wieg. Arch., I. p. 333.
" *turcarum*! BÖLSCHE, 1865. Wieg. Arch., I. p. 330. (pars)

*Society Islands (Garrett); *Kupang, Timor (Martens, Mus. Berlin); Amboina! Nikobar! (Mus. Copenh.); Pomotu Islands! (U. S. Ex. Exp., Smithson. Coll.); Wupang! (Berlin Mus.); Philippine Islands! (Semper); Sandwich Islands! (Vienna Mus.).

Echinothrix Desorii

Cidarites **calamaria**! LAMK. 1816. An. s. Vert., p. 58. (pars.) Mers d'Indes.
Diadema calamarium! DUJ. HUPÉ, 1862. Échin., p. 505. (pars.)
" " ! PERRIER, 1869. Pédic., p. 316, *Pl. IV. f. 3, 8b.*
Astropyga **Desorii**! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 345. Red Sea.
Echinothrix *Desorii* PETERS, 1853. Monatsb. Berl. Ak., p. 484.
Echinothrix " ! PETERS, 1854. Seeig. v. Moss., p. 117.
" " ! BÖLSCHE, 1865. Wieg. Archiv, p. 330.
" **scutata**! A. AGASS. 1863. Bull. M. C. Z., I. p. 19. Sandwich Islands.
" *scutata*! BÖLSCHE, 1865. Wieg. Arch., I. p. 333.
Echinothrix annellata! PETERS, 1853. Monatsb. Ak. Berl., p. 484. Mozambique.
Echinothrix annellata PETERS, 1854. Seeig. v. Moss., p. 117.
" " BÖLSCHE, 1865. Wieg. Archiv, I. p. 333.
Garelia clavata! GRAY, 1855. Proc. Zoöl. Soc. London, p. 38.
Savignya **Frappieri** MICH. 1862. Maill. An. A., *Pl. XV. f. 1–9.* Bourbon.
Echinothrix clavata BÖLSCHE, 1865. Wieg. Archiv, I. p. 333.

*Sandwich Islands (Garrett); *Feejee Islands (Mus. Godeff.); *Mauritius (Pike); Bourbon! (École Min.); *Red Sea (J. d. P., Botta).

Echinothrix turcarum

Echinometra ...... RUMPH. 1705. Amboin. Rar. Kam., *Pl. XIV. f. B.*
Diadema turcarum SCHYNV. 1711? Thes. Imag., p. 2 (teste BÖLSCHE).
Diadema turcarum! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 349. (pars.)
Echinothrix *turcarum* PETERS, 1853. Monatsb. Berl., p. 484.
Echinothrix " ! PETERS, 1854. Seeig. v. Moss, p. 116. Mozambique.
" " ! BÖLSCHE, 1865. Wieg. Arch., I. p. 330. (pars.)
" " ! BÖLSCHE, 1866. Wieg. Arch., I p. 89.
Garelia " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 19.
Echinus **diadema** LINN. 1758. Syst. Nat.
Cidaris **araneiformis** LESKE, 1778. KL. Ech., p. 116.
Echinus araneiformis GMEL. 1788. LINN. Syst. Nat., 3173.
" **coronalis** LESKE, 1778. KL. Ech., p. 116.
Cidarites **spinosissima**! LAMK. 1816. An. s. Vert., p. 58.
Diadema spinosissimum! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 308.

Echinothrix turcarum (*continued*).

Diadema spinosissimum ! Mich. 1845. Rev. Mag. Zoöl., p. 13. Isle de France.
" " ! Mart. 1866. Wieg. Arch., p. 152.
Astropyga spinosissima ! Agass. 1846. C R. Ann. Sc. Nat , VI p. 345. Mauritius. Zanzibar.
Echinothrix " Peters, 1853. Monatsb. Berl., p. 484.
Echinothrix " ! Peters, 1854. Seeig. v. Moss., p. 117.
" " ! Bölsche, 1865. Wieg. Arch., I. p. 330.
Savignya " ! Duj. Hupé, 1862. Échin., p. 506.
" " ! Perrier, 1869. Pédic., p. 137, *Pl. IV. f. 6.*
Cidarites **subularis** ! Lamk. 1816. An. s. Vert., p. 58. Isle de France.
Diadema subulare ! Agass. 1836. Prod., p. 22.
" " Desml. 1837. Syn., p. 308.
Astropyga subularis ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 345. Seychelles.
Echinothrix " Peters, 1853. Monatsb. Berl. Ak., p. 484.
Echinothrix " ! Peters, 1854. Seeig. v. Moss., p. 117.
" " ! Bölsche, 1865. Wieg. Arch., I. p. 329.
Savignya " ! Des. 1854. Syn. Éch. foss.
Savignya " ! Duj. Hupé, 1862. Échin , p. 505.
Garelia " ! A. Agass. 1863. Bull. M. C. Z., p. 18.
Diadema **Desjardinsii** ! Mich. 1844. Rev. Mag., p. 136. Isle de France.
" *Desjardinsii* ! Mich. 1845. Rev. Mag., p. 14, *Pl. VII.*
Garelia **cincta** ! A. Agass. 1863. Bull. M. C. Z., I. p. 18. Kingsmills Islands. Sandwich Islands.
Echinothrix cincta ! Bölsche, 1865. Wieg. Arch., I. p. 333.
" **Petersii** ! Bölsche, 1865. Wieg. Arch., I. p. 334, *Pl. XIII.* Feejee Islands.

*Sandwich Islands, *Society Islands, *Kingsmills Islands (Garrett); *Feejee Islands, Bonin Islands! (W. Stimpson, Smithson. Coll.); Samoa! Upolu! (Mus. Godeff.); Amboina (Rumph); Timor (Mus. Berl.); *Zanzibar (Cheney); *Mauritius (Pike); New Ireland! Red Sea! Mauritius! Isle de France! (J. d. P.); Philippine Islands! (Semper).

ECHINUS.

Echinus Rondel. 1554. De Pisc. Mar.
Cidaris Klein, 1734. Nat. Disp. Ech. (pars.)
Echinus Linn. 1758. Syst. Nat. (pars.)
Heliocidaris Agass. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Psammechinus Agass. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Sphaerechinus Duj. Hupé, 1862. Échin (pars.)

Echinus acutus

? *Cidaris* **Basteri** Leske, 1778. Kl. Add. p. 23, *Pl. XLIX. f. 2.*
Echinus **acutus** ! Lamk. 1816. An. s. Vert., p. 45.
" *acutus* ! Blainv. 1825. Dict. Sc. N. O., p. 78.
" " ! Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 270.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 365.
" " Aradas, 1853. Monog. Ech. Atti. Catania, VIII. p. 276. Sicily.
" " Caill. 1865. Cat. Rad. Ann., p. 20.
" *miliaris* Flem. 1828. Brit. An., p. 478 (non Auct.).
" **Flemingii** ! ? Ball. 1841, in Forbes, Brit. Starf., p. 164, fig.
" *Flemingii* ! Düb. o. Kor. 1844. Skand. Ech., p. 266, *Pl. IX. f. 31, 32.* Norway.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 365.
" " ! Gray, 1848. Brit. Rad., p. 3.

Echinus acutus (*continued*).

Echinus Flemingii SARS, 1857. Middelh. Litt. Faun., p. 111. Naples.
" " ! SARS, 1861. Norges Ech., p. 93.
" " ! DUJ. HUPÉ, 1862. Éch., p. 525.
" " ! GRUBE, 1864. Insel Lussin. Lussin (Adriatic).
" *sardicus* CAILL. 1865. Cat. Rad. An., p. 20 (non AUCT.). W. coast France.

*Devonshire, *W. coast Norway (Sars); *Oban, *Milford (W. Stimpson); *Mosterhavn, *Hardangerfjord (G. O. Sars); *Shetland Islands, 150 fms., *between Faroe and Shetland Islands, 400 fms., *So. Ireland, 100 fms., *Cape de Gatte, *Cape Sagras, 165 fms. (Porcup. Exped.); *Naples (Panceri); Katwijck (Maitland); Lussin (Grube); Lessina (Heller); Port Vendres! Oran! Algeria! (J. d. P.).

Echinus angulosus

Cidaris *miliaris angulosa* ! KLEIN, 1734. Nat. Disp. Ech., *Pl. III. f. A, B.*
Cidaris **angulosa** LESKE, 1778. KL. Add., *Pl. III. f. A, B*, copied in ENC. MÉTH., *Pl. CXXXIII. f. 5, 6.*
...... GUALTERI, 1742. Index Test., *Pl. CVIII. f. A*, copied in ENC. MÉTH., *Pl. CXCVIII.*
...... SEBA, 1758. Thes., III. *Pl. X. f. 20.*
...... KNORR, 1771. Délic., *Pl. D. f. 4, 5.*
...... AUDOUIN in SAVIGNY, Égypte, *Pl. VII. f. 2*
Echinus **subangulosus** ! LAMK. 1816. An. s. Vert., p. 48 (non BLAINV.).
" *subangulosus* DESML. 1837. Syn., p. 270. Cape Good Hope.
Psammechinus *subangulosus* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 368.
Psammechinus " ! DUJ. HUPÉ, 1862. Échin., p. 527.
" **verruculatus** LÜTK. 1864. Bid., p. 166.
Echinus **minimus** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 80. Cape Good Hope.
" *minimus* DESML. 1837. Syn., p. 274.
" *minutus* ! BLAINV. 1834. Actin., p. 227.

*Cape Good Hope (Wahlenberg); *Simon's Bay (W. Stimpson); *Cape Town (Layard); *Nikobar (Mus. Vienna); Butu (Bonn Mus.); Mauritius! (Stockholm); Mozambique (Bianconi); *New Zealand (Edwards); Adelaide! E. coast Australia! (Brit. Mus.); *Red Sea (Hemp. u. Ehreb. Mus. Berl.); Suez! (J. d. P.); Philippine Islands! (Semper).

Echinus elegans

Echinus elegans ! (**Düb. o. Kor.**) 1844. Skand. Echin., p. 272, *Pl. X. f. 40–42.* W. coast Norway.
" " AGASS. 1846. Ann. Sc. Nat., VI. p. 365.
" " ! SARS, 1861. Norges Echin., p. 94.
" " DUJ. HUPÉ, 1862. Échin., p. 524.

*Hardangerfjord, 150 fms. (G. O. Sars); *Cape Sagras, 80 fms., *between Faroe and Shetland Islands, 400 fms., *off Valencia, 90 fms. (Porcup. Exped.); W. coast Norway, 250 fms. (Danielsen); Bergen (Sars).

Echinus esculentus

Cidaris *miliaris* sp. II. *hemisphaerica* KLEIN, 1734. *Pl. II. f. E.*
...... KNORR, 1771. Délic., *Pl. D. f. 1; Pl. DII. f. 13*, copied in LESKE, KL. Add., *Pl. XXXVIII. f. 1.*
Echinus **subglobosus** LINN. 1745. Faun. Suec., p. 513.
" *esculentus* LINN. 1758. Syst. Nat., ed. X. p. 663 (non RUMPH nec LESKE).
" " ! GRAY, 1825. Ann. Phil., p. 4.
" " FLEM. 1828. Brit. An., p. 478.
" " ! AGASS. 1836. Prod., p. 190.
" " DESML. 1837. Syn., p. 278.
" " ! DÜB. O. KOR. 1844. Skand. Ech., p. 264. W. coast Norway.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 365. German Ocean.
" " GRAY, 1848. Brit. Rad., p. 3.
" " ! SARS, 1861. Norges Ech., p. 93.

Echinus esculentus (*continued*).

Sphaerechinus esculentus Duj. Hupé, 1862. Échin., p. 529.
" " Perrier, 1869. Pédic., p. 151, *Pl. V. f. 8 a–c.*
Cidaris **hemisphaerica** Leske, 1778. Kl. Add., p. 126.
Echinus **sphaera** !? Müll. 1776. Prod. Zool. Dan., p. 235.
" *sphaera* Penn. 1812. Brit. An., 2d ed., *Pl. XXXVI. f. 1;* 1st ed., *Pl. XXXIV. f. 1.*
" " Forbes, 1841. Brit. Starf., p. 149, fig.
" " Val. 1841. Agass. Mon. Éch., Anat. Ech., *Pl. VII.–IX.* passim.
" " Müll. 1848. Abhdl., I. *Pl. V. f. 1–8; Pl. VI., VII. f. 1–3* (Pluteus).
" " Müll. 1854. Bau d. Ech., *Pl. II. f. 1.*
" " Gosse, 1856. Tenby, fig.
" " Bronn, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 8.*
" " Stewart, 1865. Trans. Linn. Soc., XXV. *Pl. L. f. 2a.*
" **globiformis** ! Lamk. 1816. An s. Vert., p. 44.
" *globiformis* ! Blainv. 1825. Dict. Sc. Nat. O., p. 79.
" " Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 270.
" " Caill. 1865. Cat. Rad. An., p. 20.
" **subangulosus** ! Blainv. 1825. Dict. Sc. N. O., p. 78 (non Lamk.).
" *subangulosus* Blainv. 1834. Actin., p. 227.
" **pseudomelo** ! Blainv. 1825. Dict. Sc. N. O., p. 77.
" *pseudomelo* Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 270.
" **aurantiacus** ! Blainv. 1825. Dict. S. N. O., p. 79.
" *aurantiacus* Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 272.
" **quinqueangulatus** ! Blainv. 1825. Dict. Sc. N. O., p. 79.
" *quinqueangulatus* Desml. 1837. Syn., p. 270.
" **quinqueangulosus** Blainv. 1834. Actin., p. 227.
" **violaceus** ! Blainv. 1825. Dict. Sc. N. O., p. 80.
" *violaceus* ! Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 272.
" *depressus* ! Mich. MS. (Écol. Min.).

*W. Sweden, *Norway (Sars); *Lofoten Islands, l. w. m. — 80 fms. (G. O. Sars); *Oban (W. Stimpson); *Heligoland (Weinland); *Milford, *W. coast Great Britain, *Oban (W. Stimpson); English Channel, Scotland (Forbes); Finmark (Sars); Drontheim — Cape North, l. w. m. — 15 fms. (McAndrew & Barrett); Ireland! (Mus. Copenh.); Schveningen, Katwijck, Groningen (Maitland).

Echinus gracilis

Echinus **gracilis** ! A. Agass. 1869. Bull. M. C. Z., I. p. 269. Straits Florida.

*Off Sand Key, 120, 125 fms., *Florida Gulf Stream, 101, 119, 128, 150, 200 fms., *Key West, 135, 140 fms., *off Tennessee Reef, 114 fms., *off Alligator Reef, 156 fms. (Pourtalès); St. Thomas! (Duchassaing, J. d. P.).

Echinus magellanicus

Echinus **magellanicus** ! Phil. 1857. Wieg. Archiv, I. 130. Straits of Magellan.
Psammechinus magellanicus ! Duj. Hupé, 1862. Échin., p. 528.
" **cupreus** ! Trosch. MS. Mus. Frankfort.

*Patagonia (Denning); *Straits Magellan (Mus. Stockh., Mack); *Valparaiso (Loriol); *New Zealand, Australia! (Frankfort Mus.).

Echinus margaritaceus

Echinus **margaritaceus** ! LAMK. 1816. An. s. Vert., p. 47. So. Pacific ?
" *margaritaceus* ! BLAINV. 1825. Dict. Sc. Nat., p. 78.
" " ! BLAINV. 1834. Actin., p. 227.
" " DESML. 1837. Syn., p. 270.
" " ! VAL. 1846. Voyage Vénus, Zooph., *Pl. VI. f. 1.*
Heliocidaris margaritacea ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 371. So. Pacific.
" " ! DUJ. HUPÉ, 1862. Échin., p. 537.

*Cape Horn (Mus. Godeff.); So. Polar seas! (J. d. P.); New Zealand! (Smithson. Coll.); Port Otway, W. coast Patagonia! (Brit. Mus.).

Echinus melo

Echinometra ...... RONDEL. 1554. Lib. de Pisc. Mar., p. 578.
...... GUALTERI, 1742. *Pl. CVI. f. E.*
? ...... ENC. MÉTH. *Pl. CXLI. f. 1, 2.*
Echinus **melo** ! LAMK. 1816. An. s. Vert., p. 45. Mediterranean.
" *melo* RISSO, 1826. Europ. Mér., V. p. 276.
" " ! BLAINV. 1827. Dict. Sc. N. O., p. 77.
" " ! BLAINV. 1834. Actin., p. 226, *Pl. XX. f. 3.*
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 276.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 365. Algeria.
" " MÜLL. Abhdl., IV. *Pl. VII. f. 9,* (Pluteus).
" " ARADAS, 1853. Monog. Echin. Atti. Gioen., VIII. p. 275. Sicily.
" " SARS, 1857. Middelh. Litt. Fauna, p. 111. Naples.
" " ! DUJ. HUPÉ, 1862. Échin., p. 524.
" " ! GRUBE, 1864. Insel Lussin. Lussin (Adriatic).
" " CAILL. 1865. Cat. Rad. Ann., p. 19. W. coast France.

*Nice (Burkhardt, Verany); *Naples (Panceri); *W. coast Italy (Rigacci); *Venice (Lyman): Mediterranean! Oran! Alger! Cape Verde Islands! (Bouvier); W. coast Africa! Canary Islands! Spain! Portugal! (J. d. P.); Dalmatia (Müll.); Quarnero, Lussin (Grube); Lessina, 35–55 fms. (Heller).

Echinus microtuberculatus

...... KNORR, 1771. Délic., *Pl. D. f. 6.*
Echinus **microtuberculatus** ! BLAINV. 1825. Dict. Sc. N. O., p. 88. Mediterranean.
Psammechinus *microtuberculatus* ! AGASS. 1846. C. R. Ann. Sc. Nat., VII. p. 366.
Psammechinus " ! SARS, 1857. Middelh. Lit. Fauna, p. 115.
" " ! DUJ. HUPÉ, 1862. Échin., p. 526.
" " PERRIER, 1869. Pédic., p. 150, *Pl. V. f. 3 a, b.*
Echinus **parvituberculatus** ! BLAINV. 1834. Actin., p. 228.
" *parvituberculatus* DESML. 1837. Syn., p. 282.
Psammechinus parvituberculatus ! LÜTK. 1864. Bid., p. 168.
Echinus miliaris RISSO, 1820. Europ. Mérid., V. (non MÜLL. nec LINN.).
" " ARADAS, 1853. Monog. Echin. Atti. Gioen., VIII. p. 290. Sicily.
" **pulchellus** ! AGASS. 1841. VAL. Anat. gen. Ech., p. VI.
" *pulchellus* MÜLL. 1854. Abhdl., IV. p. 48, *Pl. VI. f. 1–6* (Pluteus).
" " MÜLL. 1856. Bau d. Ech., *Pl. II f. 4.*
Psammechinus pulchellus BRONN, 1859. Kl. u. Ord., p 338, Actin., *Pl. XXXIX. f. 5.*
" " DUJ. HUPÉ, 1862. Échin., p. 526.
Echinus **decoratus** ! AGASS. 1841. VAL. Anat. g. Ech., p. VII.
Psammechinus decoratus ! DUJ. HUPÉ, 1862. Échin., p. 527.

*Mediterranean, *Spezzia (Lyman); *Naples (Panceri); *W. coast Italy (Rigacci); Triest (Müller); Lissa, Lessina, Ragusa (Heller); Cape Verde Islands! (J. d. P.); Genoa, Nice (Verany); Messina (Sars).

Echinus miliaris

Cidaris *miliaris saxatilis* KLEIN, 1734. Nat. Disp. Ech., *Pl. II. f. A, B; Pl. XXXI. f. C.*
Echinus **miliaris** MÜLL. 1771. KNORR, Del.
" *miliaris* ! LAMK. 1816. A. s. Vert, p. 49. N. European Atlantic.
" " ! BLAINV. 1825. Dict. Sc. N. O., p. 80 (non FLEM.).
" " BLAINV. 1834. Actin., p. 237.
" " DESML. 1837. Syn., p. 272.
" " ! AGASS. 1841. VAL. Anat. gen. Ech., p. VI.
" " ! FORBES, 1841. Brit. Starf., p. 161, fig.
" " ! Gray, 1848. Brit. Rad., p. 3.
" " SARS, 1861. Norges Ech., p. 94.
Psammechinus *miliaris* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 368.
Psammechinus " ! DESOR, 1855. Syn. Ech. foss., *Pl. XVIII. f. 7, 8.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 526.
" " ! PERRIER, 1869. Pédic., p. 146, *Pl. V. f. 1 a–d.*
Echinus saxatilis O. F. MÜLL. 1776. Prod., p. 235 (non LINN. nec FAB.).
Cidaris " LESKE, 1778. KL. Add., p. 82, *Pl. II. f. A, B; Pl. XXXVIII. f. 2, 3*, copied in Enc. Méth., *Pl. CXXXIII. f. 1, 2.*
Echinus **pustulatus** ! AGASS. 1841. VAL. An. gen. Ech., p. VI.
Psammechinus pustulatus ! DUJ. HUPÉ, 1862 Échin. p. 527.
Echinus **virens** ! DÜB. o. KOR. 1844. Skand. Ech., p. 274, *Pl. X. f. 43, 44.* W. coast Norway.
Psammechinus Korenii DES. 1846. AGASS. C. R. Ann. Sc. Nat., VI. p. 368.
? GOSSE, 1856. Tenby, Pluteus, fig.

*Norway, *Oresund (Mus. Copenh.); *Dröback (Eschricht); *Boulogne; *Oban (W. Stimpson); English Channel! Liverpool! Milford! (Liverpool Mus.); S. W. coast Sweden (Sars); Ireland (Thomson); Drontheim — Cape North (McAndrew & Barrett); W. Scotland, N. Ireland, Guernsey (Forbes); Schveningen, Katwijck, Doneburg (Maitland).

Echinus norvegicus

Echinus **norvegicus** ! DÜB. o. KOR. 1844. Skand. Echin., p. 268, *Pl. IX. f. 33–39.* W. coast Norway.
" *norvegicus* ! SARS, 1861. Norges Echin., p. 94.
Psammechinus *norvegicus* ! AGASS. DES. 1846. C. R. Ann. Sc. Nat., VI. p. 368.
Psammechinus " ! DUJ. HUPÉ, 1862. Échin., p. 526.
Echinus Flemingii ! A. AGASS. 1869. Bull. M. C. Z., I. p. 262 (non AUCT.). Straits Florida.
" *depressus* G. O. SARS, 1871. Vidensk. Selsk. Forh., p. 23 (non BLAINV.). Lofoten.
" **rarispinus** ! G. O. SARS, 1871. MS. Lofoten.

*North Sea, 200 fms. (Mus. Stock.); *Lofoten Islands, 200–300 fms., Storggen Bank, 80–100 fms. (G. O. Sars); *Shetland Islands, *off Valencia, *between Faroe and Shetland Islands, 400 fms. *Cape Wrath, 300 fms., *Adventure Bank (Porcupine Exped.); W. coast Norway, 450 fms. (Danielsen); *Florida Gulf Stream, 195 fms. (Pourtalès); Salterfjord 150–200 fms. (G. O. Sars).

ENCOPE.

Echinodiscus LESKE, 1778. KL. Add. (pars.)
Echinus GMEL. 1788. Syst. Nat. (pars.)
Scutella LAMK. 1816. An. s. Vert. (pars.)
Encope AGASS. 1840. Cat. Syst. Ectyp.
Encope AGASS. 1841. Monog. Scut.
Echinoglycus GRAY, 1855. Cat. Rec. Ech. (pars.)
Mellita AGASS. 1841. Monog. Scut. (pars.)
Moulinia AGASS. 1841. Monog. Scut.
Moulinsia AGASS. 1847. C. R. Ann. Sc. Nat., VII. (non GRATEL, 1840).

Encope californica

Encope **californica**! VERRILL, 1870. Sill. Journ., p. 97. La Paz.
" *californica*! VERRILL, 1871. Notes Radiata, p. 586, *Pl. X. f. 5, 6.* Cape St. Lucas.

*La Paz (Pedersen, Yale Coll.).

Encope emarginata

...... SEBA, 1758. Thes., III. *Pl. XV. f. 5, 6*, copied in Enc. Méth., *Pl. CXLVIII.*
Echinodiscus **emarginatus** LESKE, 1778. KL. Add., p. 136, *Pl. L. f. 5, 6*, copied in Enc. Méth., *Pl. CL. f. 1, 2.*
Echinus emarginatus GMEL. 1788. LINN. Syst. N., 3189.
Scutella *emarginata*! LAMK. 1816. An. s. Vert., p. 9.
Scutella " ! BLAINV. 1825. Dict. Sc. N. Scut., p. 224.
" " ! BLAINV. 1834. Actin., p. 219.
" " ! AGASS. 1836. Prod., p. 188.
" " DESML. 1837. Syn., p. 222.
Encope " ! AGASS. 1841. Mon. Scut., p. 47, *Pl. X.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 137. Rio Janeiro.
" " ! DUJ. HUPÉ, 1862. Échin., p. 567.
" " ! LÜTK. 1864. Bid., p. 111, *Pl. II. f. 4, 5.* W. Indies.
" " ! VERRILL, 1868. Notes Radiata, p. 370. Rio, Bahia.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 267, 289. Straits Florida.
Echinodiscus **quaterperforatus** LESKE, 1778. KL. Add., p. 140.
Echinus **tetraporus** GMEL. 1788. LINN. Syst. N., 3189.
Scutella tetrapora BLAINV. 1834. Actin., p. 219, *Pl. XVIII. f. 4.*
Scutella quadrifora LAMK. 1816. An. s. Vert., p 9.
Scutella quadrifora BLAINV. 1825. Dict. Sc. Nat. Scut., p. 224.
" " DESML. 1837. Syn., p. 224.
" **quinqueloba** ESCH. 1829. Zool. Atl., *Pl. XX. f. 1.* Rio Janeiro.
Encope quinqueloba! GRUBE, 1857. Nov. Act., XXVII. p. 46.
Scutella **cassidulina** DESML. 1837. Syn., p. 232. Martinique.
Moulinia *cassidulina*! AGASS. 1841. Mon. Scut., p. 139, *Pl. XXII. f. 1–6.*
Moulinsia " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 139.
" " ! GRAY, 1855. Cat. Rec. Ech, p. 27.
" " ! DESOR, 1857. Synops. Ech. foss., *Pl. XXVII. f. 14–16.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 558.
" " ! LUTK. 1864. Bid., p. 118.
Encope **Valenciennesii**! AGASS. 1841. Mon. Scut., p. 54, *Pl. VII., VIII.* Martinique.
" *Valenciennesii*! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! DUJ. HUPÉ, 1862. Échin., p. 569.
" **subclausa**! AGASS. 1841. Mon. Scut., p. 56, *Pl. V. f. 5.* Brazil.
" *subclausa*! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 137.

Encope emarginata (*continued*).

Encope subclausa ! Duj. Hupé, 1862. Échin., p. 569.
" **oblonga** ! Agass. 1841. Mon. Scut., p. 53, *Pl. IX.* Rio Janeiro.
" *oblonga* ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! Duj. Hupé, 1862. Échin., p. 569.
Mellita **lobata** ! Agass. 1841. Mon. Scut., p. 44, *Pl. IV^a. f. 13.*
" *lobata* ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 139.
" " ! Mich. 1858. Rev. Mag. Zoöl., No. 8.
" " ! Duj. Hupé, 1862. Échin., p. 567.
" **nummularia** ! Val. 1847. Agass. C. R. Ann. Sc. Nat., VII. p. 139.
" *nummularia* ! Gray, 1855. Cat. Rec. Ech., p. 24.
" " ! Duj. Hupé, 1862. Échin.
Encope **Ghiesbrechtii** Belval, 1863. Bull. Acad. Brux., XV. p. 419.
Echinoglycus frondosus ! Gray, 1855. Cat. Rec. Ech., p 24. Nicaragua.

*Desterro, Brazil (F. Müller); *Rio Janeiro, *Maranhao (Agassiz, Thayer Exp.); *Victoria, *Sta. Anna Island (Hartt & Copeland, Thayer Exped.); *West Indies; *Cumana, Venez. (Couthouy); Bahia, Itapaji, Purpui, San Antonio (Hartt); *Florida Gulf Stream, 7 fms. (Pourtalès); Martinique! (Mus. Neuftl., Brit. Mus.); Nicaragua! Yucatan! (Brit. Mus.); Pernambuco (Belval); Charleston, S. C.! (Gibbes).

Encope grandis

Encope grandis ! Agass. 1840. Cat. Syst. Ectyp.
Encope grandis ! Agass. 1841. Mon. Scut., p. 57, *Pl. VI.*
" " ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! Duj. Hupé, 1862. Échin., p. 569.
" " ! A. Agass. 1863. Bull. M. C. Z., I. p. 26. Gulf California.
" " ! Verrill, 1867. Notes Radiata, p. 310. La Paz.
" " ! Verrill, 1871. Notes Radiata, p. 585.
Echinoglycus *grandis* ! Gray, 1855. Cat. Rec. Ech., p. 26.
Encope **Agassizii** ! Mich. 1851. Rev. Mag. Zoöl., No. 2.
" *Agassizii* ! Duj. Hupé, 1862. Échin., p. 569.

*Lower California (Caldwell, Stone); *Guaymas (Stone); *La Paz (Pedersen, Yale Coll.).

Encope Michelini

Encope **Michelini** ! Agass. 1841. Mon. Scut., p. 58, *Pl. VI^a. f. 9, 10.* Yucatan.
" *Michelini* ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! Duj. Hupé, 1862. Échin., p. 569.
" " A. Agass. 1863. Bull. M. C. Z., I. p. 27. Tampa Bay.
" " A. Agass. 1869 Bull. M. C. Z., I., p. 266. Straits Florida.
Echinoglycus frondosus ! Gray, 1855. Cat. Rec. Ech., p. 25, Var. 5.
Encope **aberrans** ! Mart. 1867. Wieg. Arch., I. p. 112. Campiche Bay.

*Yucatan; *Tampa Bay, Fla., *Captiva Key, Fla. (Würdemann); *off Sarrasota Bay, 5 – 6 fms. *Rebecca Shoals (Pourtalès); *Alabama; Campiche Bay! (Mus. Berl.).

Encope micropora

Encope **micropora** ! Agass. 1841. Mon. Scut., p. 50, *Pl. X^a. f. 4 – 8; Pl. XIX^a. f. 7.*
" *micropora* ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! Duj. Hupé, 1862. Échin., p. 568.
Encope **cyclopora** ! Agass. 1841. Mon. Scut, p. 52, *Pl. X^b. f. 6 – 9.*
" *cyclopora* ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! Duj. Hupé, 1862. Échin., p. 568.
Echinoglycus *cyclopora* ! Gray, 1855. Cat. Rec. Ech., p. 26.
Encope **perspectiva** ! Agass. 1841. Mon. Scut., p. 51, *Pl. X^b. f. 1 – 5.*

Encope micropora (*continued*).

Encope perspectiva ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 137.
" " ! DUJ. HUPÉ, 1862. Échin., p. 568.
Echinoglycus *perspectiva* ! GRAY, 1855. Cat. Rec. Ech., p. 26.
Encope tetrapora ! AGASS. 1841. Mon. Scut., p. 49, *Pl. X^a f. 1–3* (non AUCT.). Galapagos.
" " ! AGASS. 1847. C. R. Ann. Sc. N., VII. p 137. (pars.)
Echinoglycus *tetrapora* ! GRAY, 1855. Cat. Rec. Ech., p. 26.
Encope **occidentalis** ! VERRILL, 1867. Notes Radiata, p. 309. Panama. Zorritos.
" *occidentalis* ! VERRILL, 1871. Notes Radiata, *Pl. X. f. 4.*
" **Lapeyrousii** MICH. MS. (Écol. Min.).
" **elegans** MICH. MS. (Écol. Min.).
" **Sebae** MICH. MS. (Écol Min.).
" **mellitifrons** MICH. MS. (Écol. Min.).

*Lower California (Gibbes); *Guaymas (Stone); *Cape St. Lucas (Xanthus, Smithson. Coll.); Mazatlan! (Bonn Mus. Écol. Min.); *Panama (Maack; Bradley, Yale Coll.); Galapagos.

(SPATANGUS.) EUPATAGUS.

Eupatagus AGASS. 1847. C. R. Ann. Sc. Nat., VIII.

Eupatagus Valenciennesii

Eupatagus Valenciennesii ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 9, *Pl. XVI. f. 13.* New Holland.
Eupatagus Valenciennesii ! GRAY, 1855. Cat. Rec. Ech., p. 49. Van Diemen's Land.
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XLII. f. 7.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 60.
" **similis** ! GRAY, 1851. Ann. Mag. N. H., p. 130.

*New Holland; *Australia (Liverpool Mus.); Van Diemens Land! Port Dalrymple! Bass Straits! Flinder's Island! (Brit. Mus.).

(HIPPONOË.) EVECHINUS.

Echinus VAL. 1846. Voyage Vénus. (pars.)
Heliocidaris DESML. 1847. AGASS. C. R. Ann. Sc. Nat., VII. (pars.)
Psammechinus GIR. 1850. Proc. Boston Sc. N. H.
" A. AGASS. 1863. Bull. M. C. Z. (pars.)
Boletia VERRILL, 1867. Notes Radiata. (pars.)
Evechinus VERRILL, 1871. Notes Radiata. .

Evechinus chloroticus

Echinus **chloroticus** ! VAL. 1846. Voyage Vénus, Zooph., *Pl. VII. f 2.* New Zealand.
Heliocidaris *chlorotica* ! DESML. 1846. AGASS. C. R. Ann. Sc. Nat, VI. p. 371.
Psammechinus chloroticus ! A. AGASS. 1863. Bull. M. C. Z., I. p. 23.
Evechinus " ! VERRILL, 1871. Notes Radiata, p. 584.
Psammechinus **asteroides** ! GIR. 1850 Proc. Bost. Soc. N. H, p. 366.
Boletia **viridis** ! VERRILL, 1867. Notes Radiata, p. 304.

*New Zealand, *Auckland (Edwards).

(LINTHIA.) Faorina.

Faorina Gray, 1851. Ann. Mag. N. H.
Tripylus Trosch. 1851. Wieg. Archiv, I. p. 72. (pars.)
Atrapus Trosch. 1851. Wieg. Arch., I. p. 72.

Faorina chinensis

Faorina chinensis ! Gray, 1851. Ann. Mag. N. H., VII. p. 132.
Faorina chinensis ! Gray, 1855. Cat. Rec. Echin., p. 57, *Pl. VI. f. 1.* China.
Tripylus (**Atrapus**) **grandis** ! Trosch. 1851. Wieg. Arch., p. 72, *Pl. I.*

*Shanghae; *Sandwich Islands? (Garrett); China! Hong Kong (Brit. Mus.).

FIBULARIA.

Echinus Pall. 1774. Spic. Zoöl.
Echinocyamus Leske, 1778. Kl. Addit. (pars)
Fibularia Lamk. 1816. An. s. Vert. (pars.)
Fibularia Agass. 1847. C. R. Ann. Sc. Nat., VII. (pars.)
Echinocyamus Agass. 1847. C. R. Ann. Sc. Nat., VII. (pars.)
Mortonia Gray, 1851. Proc. Zoöl. Soc. London (non Des. 1856).

Fibularia australis

...... Seba, 1758. Thes., III. *Pl. XV. f. 36.*
Fibularia **australis** Desml. 1837. Syn., p. 240 (non A. Agass.).
Echinocyamus australis ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 140. South Pacific.
" " Duj. Hupé, 1862. Échin., p. 556.
" " ! Mich. 1859. Rev. Mag. Zoöl., p. 9, *Pl. XIV. f. 2.*
Mortonia *australis* ! Gray, 1851. Proc. Zoöl. Soc. London, p. 38.
Mortonia " Gray, 1852. Ann. Mag. N. H., p. 448. Australia.
" " Gray, 1855. Cat. Rec. Ech., p. 37.

*Sandwich Islands, *Kingsmills Islands (Garrett); Ousima! Coral Sea of Australia! (W. Stimpson, Smithson. Coll.); South Sea! (J. d. P., Brit. Mus.).

Fibularia ovulum

Echinus **minutus** Pall. 1774. Spic. Zoöl., IX. *Pl. I. f. 3a.*
" *minutus* Gmel. 1788. Linn. Syst. Nat., 3194.
Echinocyamus **craniolaris** Leske, 1778. Kl. Add., p. 150, *Pl. XLVII. f. 3a.*
Echinus craniolaris Gmel. 1788. Linn. Syst. N., 3193.
Fibularia " De Fr. 1820. Dict. Sc. Nat., XVI. p. 512.
" " Des Long. 1824. Enc. Méth., *Pl. CLIV. f. 1, 2.*
" " ! Blainv. 1834. Actin., p. 211.
" " ! Agass. 1836. Prod., p. 20.
" " Gray, 1855. Cat. Rec. Echin., p. 29.
Echinocyamus **nucleo cerasi** Leske, 1778. Kl. Add.
" **ervum** Leske, 1778. Kl. Add.
Echinus ervum Gmel 1788. Linn. Syst. N, 3193.
Echinocyamus **vertice centrali** Leske, 1778. Kl. Add.
" **turcicus** Leske, 1778. Kl. Add.
Echinus turcicus Gmel. 1788. Linn. Syst. N. 3193.

Fibularia ovulum (*continued*).

Echinocyamus **ovatus** LESKE, 1778. KL. Add.
" **lathyrus** LESKE, 1778. KL. Add., *Pl. XXVIII. f. 1.*
Echinus lathyrus GMEL. 1788. LINN. Syst. N., 3194.
Fibularia " DE FR. 1820. Dict. Sc. Nat., XVI. p. 512.
" " DES LONG. 1824. E. M., II. p. 390.
" " DESML. 1837. Syn., p. 240.
Echinocyamus **equinus** LESKE, 1778. KL. Add.
Echinus equinus GMEL. 1788. LINN. Syst. N, 3194.
Echinocyamus **inaequalis** LESKE, 1778. KL. Add.
Echinus inaequalis GMEL. 1788. LINN. Syst. N., 3194.
Fibularia " DE FR. 1820. Dict. Sc. Nat., XVI. p. 512.
" " DESML. 1837. Syn., p. 236.
Echinocyamus **cor ranae** LESKE, 1778. KL. Add.
" **cor raninum** LESKE, 1778. KL. Add.
Echinus **nucleus** GMEL. 1788. LINN. Syst. N., 3193.
Fibularia nucleus DESML. 1837. Syn., p. 240.
" *nucleum* DE FR. 1820. Dict. Sc Nat., XVI. p. 511.
Echinus **centralis** GMEL. 1788. LINN. Syst. N., 3193.
" **ovulum** GMEL. 1788. LINN. Syst. N., 3194.
Fibularia *ovulum* ! LAMK. 1816. An. s. Vert., p. 17.
Fibularia " DE FR. 1820. Dict. Sc. Nat., XVI. p. 511.
" " ! BLAINV. 1834. Actin., p. 211.
" " ! AGASS. 1836. Prod., p. 20.
" " DESML. 1837. Syn., p. 240.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 142.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 30.
" " ! DUJ. HUPÉ, 1862. Échin., p. 557.
Echinocyamus ovulum ! GRAY, 1825. Ann. Phil., p. 6.
Echinus **faba** GMEL. 1788. LINN. Syst. N., 3194.
" **raninus** GMEL. 1788. LINN. Syst. N., 3195.
" **bufonius** GMEL. 1788. LINN. Syst. N. 3195.
Fibularia trigona ! LAMK. 1816. An. s. Vert., p. 17.
Fibularia trigona DE FR. 1820. Dict. Sc. Nat., XVI. p. 511.
Echinocyamus trigona ! GRAY, 1825. Ann. Phil., p. 6.
Fibularia trigona ! BLAINV. 1834. Actin., p. 211.
" " DESML. 1837. Syn., p. 238.
" " ! AGASS. 1847. C. R Ann. Sc. Nat., VII. p. 142.
" " ! PERRIER, 1869. Pédic., p. 168.
" **nucleola** DES LONG. 1824. E. M., II. 389.

*Indian Ocean; E. India Islands! (J. d. P.); Philippine Islands! (Semper).

Fibularia volva

Fibularia **volva** ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 142. Red Sea.
" *volva* ! DUJ. HUPÉ, 1862. Échin.
Fibularia **oblonga** ! GRAY, 1851. Proc Zoöl. Soc., p. 37. N. Australia.
" *oblonga* ! GRAY, 1855. Cat. Rec. Ech., p. 30, *Pl. II. f. 5.*

*Red Sea; N. Australia! (Brit. Mus.); Channel of Formosa? (Mus. Copenh.).

GONIOCIDARIS.

Cidarites LAMK. 1816. An. s. Vert. (pars.)
Cidaris BLAINV. 1834. Actinol. (pars.)
Goniocidaris DES. 1846. C. R. Ann. Sc. Nat., VI.
Temnocidaris (**A. Agass.**) 1863. Bull. M. C. Z., I. (non COTT.).

Goniocidaris canaliculata

Temnocidaris **canaliculata** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 18.

*So. Extrem. So. America (Mack); Cape Horn! (Brit. Mus.); Falkland Islands! (Cunningham); Straits Magellan! (Berlin Mus.); Rose Island! Orange Harbor! (U. S. Ex. Exped. Smithson. Coll.); Zanzibar! (Leipzig Mus.); Natal! (Krauss).

Goniocidaris geranioides

...... SEBA, 1758. Thes., III. *Pl. XIII. f. 8*, copied in Enc. M., *Pl. CXXXVI. f. 1.*
Cidarites **geranioides** ! LAMK. 1816. An. s. Vert., p. 56. E. India.
" *geranioides* DESML. 1837. Syn., p. 324.
Cidaris " ! BLAINV. 1834. Actinol, p. 231.
" " ! AGASS. 1836. Prod., p. 21. Port Western.
Goniocidaris *geranioides* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 337. New Holland. New Ireland.
Goniocidaris " DESOR, 1855. Syn. Éch. foss., *Pl. I. f. 4.*
" " BRONN, 1859. Kl. u. Ord. Actin, *Pl. XLI., f. 2.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 472, *Pl. IX. f. 5.*
" " ! STEWART, 1866. Trans. Lin. Soc., XXV. *Pl. XLVIII. f. 13 – 16.*
" " ! PERRIER, 1869. Pédic., p. 132, *Pl. III. f. 12.*

*Port Western, Australia; *Hobart Town, Van Diemen's Land (Robertson); *East India; King George's Sound! Freemantle! E. coast Australia! Brisbane Water! (Brit. Mus.).

Goniocidaris tubaria

Cidarites **tubaria** ! LAMK. 1816. An. s. Vert., p. 57 (non *Steph. tubaria* A. AG.). New Holland.
" *tubaria* DESML. 1837. Syn., p. 326.
Cidaris " ! AGASS. 1834. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 327.
" " ! DUJ. HUPÉ, 1862. Échin., p. 471.
" " ! LÜTK. 1864. Bid., p. 137.
" " ! PERRIER, 1869. Pédic., p. 127.
Goniocidaris **Quoyi** ! VAL. 1846. AGASS., DES. C. R. Ann. Sc. Nat., VI. p. 337. New Holland.
Goniocidaris Quoyi ! DUJ. HUPÉ, 1862. Échin., p. 486.
" " PERRIER, 1869. Pédic., p. 132.
Cidaris **spinulosa** ! GRAY, 1855. Proc. Zoöl. Soc. London, p. 38.

*Bass Straits (Mus. Godeff.); *Australia; *Tasmania (Liverpool Mus.); *Hobson Bay, Victoria (Edwards).

HEMIASTER.

Hemiaster Des. 1847. C. R. Ann. Sc. Nat., VII.
Tripylus Phil. 1845. Wieg. Archiv, I.
Abatus Trosch. 1851. Wieg. Archiv, I.

Hemiaster australis

Tripylus australis! Phil. 1845. Wieg. Archiv, p. 347, *Pl. XI. f. 3.* So. Extrem. So. America.
Tripylus (**Abatus**) *australis*! Trosch. 1851. Wieg. Arch., p. 72.
Brissopsis australis! Agass. 1847. C. R. Ann. Sc. Nat., VIII. p. 5.
" " ! Duj. Hupé, 1862. Échin., p. 597.
Faorina " ! Gray, 1851. Ann. Mag. N. H., VII. p. 132.
Faorina " ! Gray, 1855. Cat. Rec. Echin., p. 57.

*M. C. Z.; Statten Land! So. Polar seas! (Brit. Mus.); So. Extrem. So. America! (Philippi); Cape Virgines; off La Plata! 50 fms. (Mus. Stockholm).

Hemiaster cavernosus

Tripylus cavernosus! Phil. 1845. Wieg. Archiv, p. 345, *Pl. XI. f. 2.* So. Extrem. So. Am.
Tripylus (**Abatus**) *cavernosus*! Trosch. 1851. Wieg. Archiv, p. 72.
Brissopsis cavernosa! Agass. 1847. C. R. Ann. Sc. Nat., VIII p. 5.
" " ! Duj. Hupé, 1862. Échin p. 597.
Faorina " ! Gray, 1851. Ann. Mag N. H., VII. p. 132.
Faorina " ! Gray, 1855. Cat. Rec. Echin., p. 57.
Faorina antarctica! Gray, 1851. Ann. Mag. N. H., VII. p. 132. South Polar Sea.
Faorina antarctica! Gray, 1855. Cat. Rec. Echin., p. 57.

*M. C. Z.; Statten Land (Brit. Mus.); Chili, So. Extrem. So. America! (Philippi).

(PSEUDODIADEMA.) Hemipedina.

Hemipedina Wright, 1855. Brit. Ool. Ech.
Hemipedina Desor, 1856. Syn. Ech. foss.
Caenopedina A. Agass. 1869. Bull. M. C. Z., I.

Hemipedina cubensis

Caenopedina cubensis! A. Agass. 1869. Bull. M. C. Z., I. p. 256. Straits of Florida.

*Off Havana, 270 fms., *Florida Gulf Stream, 138 fms. (Pourtalès).

HETEROCENTROTUS.

Echinometra ...... RUMPH, 1705. Amb. Rar. Kam.
Cidaris KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinus LIN. 1758. Syst. Nat. (pars.)
Echinometra GRAY, 1825. Ann. Phil. (pars.)
Heterocentrotus BRANDT, 1835. Prod.
Acrocladia AGASS. 1840. Cat. Syst. Ectyp.
Acrocladia AGASS. 1846. C. R. Ann. Sc. Nat., VI.

Heterocentrotus mammillatus
...... RUMPH. 1705. Amb. Rar. Kam., *Pl. XIII. f. 1, 2.*
...... SEBA, 1758. Thes., III. *Pl. XIII. f. 1, 2*, copied in Enc. Méth., *Pl. CXXXVIII. f. 1, 3, 4.*
...... KNORR, 1771. Délic., *Pl. D. f. 3.*
Cidaris mammillata ! KLEIN, 1734. Nat. Disp. Ech., *Pl. VI. f. A, B.*
Cidaris mammillata LESKE, 1778. KL. Add., *Pl. XXXIX. f. 1*, copied from SEBA.
Echinus mammillatus LINN. 1758. Syst. Nat., ed. X. p. 667.
" " GMEL. 1778. LINN. Syst. N., 3175.
" " ! LAMK. 1816. An. s. Vert., p. 51. Red Sea. East Indies.
" " ! BLAINV. 1825. Dict. Sc. Nat. O., p. 97.
Echinometra *mammillata* ! GRAY, 1825. Ann. Phil., p. 5.
Echinometra " ! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 22.
" " DESML. 1837. Syn., p. 264.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XIII. f. 1.*
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 12. Isle de France.
Heterocentrotus *mammillatus* BRANDT, 1835. Prod., p. 266.
Heterocentrotus " ! A. AGASS. 1863. Bull. M. C. Z., I. Sandwich Islands.
" " ! A. AGASS. 1863. Proc. A. N. S Phila., p. 354.
Acrocladia *mammillata* ! AGASS. 1840. Cat. Syst. Ectyp.
Acrocladia " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 374.
" " ! DUJ. HUPÉ, 1862. Échin., p. 539.
" " ! MART. 1866. Wieg. Arch., I. p. 166.
" " ! PERRIER, 1869. Pédic., p. 162, *Pl. VI. f. 1^{a-e}.*
Echinus **carinatus** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 98. (pars.)
Echinometra carinata ! BLAINV. 1834. Actin., p. 225. (pars.)
" " DESML. 1837. Syn., p. 266. (pars.)
" " EYD. et SOUL. 1844. Voyage de la Bonite, Zoop., *Pl. I.*
Heterocentrotus *carinatus* BRANDT, 1835. Prod., p. 265.
" **Postellsii** BRANDT, 1835. Prod., p. 265. Bonin Islands
Echinometra Postellsii DESML. 1837. Syn., p 268.
Acrocladia **hastifera** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 374. Sandwich Islands.
" *hastifera* ! DUJ. HUPÉ, 1862. Échin., p. 540.
" " ! PERRIER, 1869. Pédic., p. 164, *Pl. VI. f. 3 a, b.*
Echinometra **Blainvillii** DESML. 1837. Syn., p. 264. (pars.)
Acrocladia **Blainvillei** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 374. (pars.)
" *Blainvillei* ! DUJ. HUPÉ, 1862. Échin., p. 540. (pars.)
" **planissima** ! MART. 1866. Zool. Bot. Ges. Wien.
" *planissima* ! MART. 1869. Decken, Reise.
" **serialis** ! VAL. PER. 1869. Pédic., p. 165, *Pl. VI. f. 5^a.*
Echinometra **depressa** ! BLAINV. MS. (J. d. P.). (pars.)
" **coronata** ! BLAINV. MS. (J. d. P.).

*Sandwich Islands (Garrett); *Manila; *Bonin Islands (W. Stimpson, Smithson. Coll.); *Feejee Islands; *Jarvis Island, No. 1; *Mauritius (Pike); Bourbon! (Écol. Min.); Loo Choo Islands! (Smithson. Coll.); Siam! (Acad. N. S. Phila.); Caroline Islands (Martens); Seychelles! Guam! (J. d. P.); Molucca, Amboina, Flores, Timor (Martens); Philippine Islands! (Semper); Upolu! (Mus. Godeff.); New Caledonia! (Crosse); *Red Sea (Mus. Vienna).

Heterocentrotus trigonarius

...... GUALTERI, 1742. Index Test., *Pl. CVIII. f. B.*
...... SEBA, 1758. Thes., III. *Pl. XIII. f. 4*, copied in Enc. Méth., *Pl. CXXXIX. f. 2.*
Cidaris mammillata! KLEIN, 1732. Nat. Disp. Ech., *Pl. VI. f. C, D.* (pars.)
Echinus **trigonarius**! LAMK. 1816. An. s. Vert., p. 51.
" *trigonarius*! BLAINV. 1825. Dict. Sc. Nat. O., p. 98.
Echinometra trigonaria! BLAINV. 1834. Actin., p. 225.
" " ! AGASS. 1836. Prod., p. 23.
" " ! DESML. 1837. Syn., p. 266.
" " ! MICH. 1845. Rev. Mag. Zool., p. 12. Isle de France.
Heterocentrotus *trigonarius* BRANDT, 1835. Prod., p. 266.
Acrocladia trigonaria! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 373. Salomon Islands.
" " ! DUJ. HUPÉ, 1862. Échin., p. 539.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. Kingsmills Islands.
" " ! STEWART, 1865. Trans. Lin. Soc., XXV. *Pl. L. f. 6.*
" " ! MART. 1866. Wieg. Arch., I. p. 167.
" " ! PERRIER, 1869. Pédic., p. 164, *Pl. VI. f. 4 a–c, f. 5 b.*
...... CARPENT. 1870. Month. Mic. J., *Pl. XLIX.*
Heterocentrus trigonarius MÜLL. 1854. Bau d. Ech., p. 8.
Echinus **carinatus**! BLAINV. 1825. D. S. N. O., p. 98. (pars.)
Echinometra carinata! BLAINV. 1834. Actin., p. 225. (pars.)
" " ! AGASS. 1836. Prod., p. 22. (pars.)
" " DESML. 1837. Syn., p. 264. (pars.)
" **Blainvillii** DESML. 1837. Syn., p. 264. (pars.)
Acrocladia **Blainvillei**! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 374. (pars.)
" *Blainvillei*! DUJ. HUPÉ, 1862. Échin., p. 540. (pars.)
Echinometra **pugionifera** DESML. 1837. Syn., p. 266.
Acrocladia **cuspidata**! A. AGASS. 1863. Bull. M. C. Z., I. p. 21. Mauritius.
" *violacea*! PERRIER, 1869. Pédic., p. 163, *Pl. VI. f. 2 a, b, c, d.*
Echinometra **violacea**! BLAINV. MS. (Mus. Paris.)
" **depressa**! BLAINV. MS. (Mus. Paris.) (pars.)
Acrocladia **yanthina** MICH. MS. (Écol. Min.)
" **subviridis** MICH. MS. (Écol. Min.)

*Mauritius (Pike); *Society Islands, *Sandwich Islands, *Paumotu Islands, *Kingsmills Islands, (Garrett); *Tonga Tabu (U. S. Ex. Exp., Smithson. Coll.); Feejee Islands! (Smithson. Coll.); Salomon Islands! Madagascar! (J. d. P.); Ellice Islands! (Mus. Godeff.); New Caledonia! (Crosse); Java (Martens); Bourbon! (Écol. Min.).

HIPPONOË.

Cidaris KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinus LAMK. 1816. An. s. Vert. (pars.)
Hipponoë GRAY, 1840. Syn. Brit. Mus.
Tripneustes AGASS. 1841. Int. Mon. Scut.
Tripneustes AGASS. 1846. C. R. Ann. Sc. Nat., VI.
Heliechinus GIR. 1850. Proc. Bost. Soc. N. H.

Hipponoë depressa

Tripneustes **depressus**! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Guaymas.
" *depressus* VERRILL, 1867. Notes Radiata, p. 375. La Paz.
" " ! VERRILL, 1869. Proc. Bost. Soc N. H., p. 384.
" " ! VERRILL, 1871. Notes Radiata, p. 584.

*La Paz (Pedersen, Yale Coll.); *Atlata (Salmin); *Gulf of California (Pedersen, Yale Coll.); Guaymas! (Smithson. Coll.).

Hipponoë esculenta

...... SLOANE, 1725. Jam., *Pl. CCXLII. f. 1, 2.*
Cidaris *miliaris esculenta* ! KLEIN, 1734. *Pl. I. f. A, B.*
Cidaris esculenta (**Leske**) 1778. KL. Add., *Pl. I. f. A, B* (non RUMPH).
Echinus **ventricosus** ! LAMK. 1816. An. s. Vert., p. 44.
" *ventricosus* ! BLAINV. 1825. Dict. Soc. N. O., p. 91.
" " ! BLAINV. 1834. Actin., p. 229.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn, p. 286.
" " Énc. Méth., *Pl. CXXXII. f. 2, 3,* copied from KLEIN.
Tripneustes *ventricosus* ! AGASS. 1841. Int. Mon. Scut.
Tripneustes " ! AGASS. 1847. C. R. Ann. Sc. N, VII. p. 363. Martinique. Yucatan.
" " ! DUJ. HUPÉ, 1862. Échin., p. 533.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Florida.
" " ! LÜTK. 1864. Bid., p. 95. W. Indies.
" " ! PERRIER, 1869. Pédic., p. 154, *Pl. V. f. 4 a–d.*
Heliechinus Gouldii ! GIR. 1850. Proc. Boston Soc. N. H., p. 364.

*West Indies, Jamaica (Adams); *Hayti (Weinland, Uhler); *Cumana (Couthouy); *St. Thomas (Allen, Thayer Exp.); *Cuba; *Florida (Würdeman); Cape Florida (Holder, Mills, Woodbury); *Tortugas (Agassiz, Pourtalès); *Bermudas (Hammond); *Nassau (Shaw); *Bahamas (Bryant); *Key West (Pickering); *Florida Reef (Pourtalès); Cuba! (Arango); Martinique! Yucatan! (J. d. P.); Surinam! (Mus. Copenh.).

Hipponoë variegata

Echinus **esculentus** RUMPH, 1705. Amb. Rar. Kam.
Cidaris *assulata* ...... KLEIN, 1734. Nat. Disp. Echin., *Pl. IX. f. A, B.*
" " *variegata* ! KLEIN, 1734. Nat. Disp. Ech., *Pl. X. f. B, C.*
Cidaris **variegata** LESKE, 1778. KL. Add., p. 85, *Pl. X. f. B, C.*
" **sardica** LESKE, 1778. KL. Add., p. 146, *Pl. IX. f. A, B.*
Echinus sardicus ! LAMK. 1816. An. s. Vert., p. 45.
" " ! BLAINV. 1834. Actin., p. 229.
" " DESML. 1837. Syn., p. 284.
Tripneustes sardicus ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 363. Seychelles. Bombay.
" " ! DUJ. HUPÉ, 1862. Échin., p. 533.
" " ! MART. 1866. Wieg. Arch., I. p. 160. Timor, Flores.
Hipponoë sardica GRAY, 1855. Proc. Zoöl. Soc. London, p. 36.
" " A. AGASS. 1863. Bull M. C. Z., I. p. 24. Zanzibar.
Cidaris ...... *angulosa* ! KLEIN, 1734. Nat. Disp. Ech., *Pl. II. f. F.* (pars.)
Cidaris **angulosa** LESKE, 1778. KL. Add., *Pl. II. f. F.*
Echinus angulosus ! BLAINV. 1825. D. S. N. O., p. 93.
" " ! BLAINV. 1834. Actin., p 229.
Tripneustes " ! DUJ. HUPÉ, 1862. Échin., p. 533.
Echinus **pentagonus** ! LAMK. 1816. An. s. Vert., p. 46.
" *pentagonus* DESML. 1837. Syn., p. 288.
" " ! MICH. 1845. Rev. Mag. Z., p. 9. Isle de France.
Tripneustes " ! AGASS. 1847. C. R. Ann. Sc. Nat., VI. p. 363.
Echinus **subcoeruleus** ! LAMK. 1816. An. s. Vert., p. 49. So. Pacific.
" *subcoeruleus* ! BLAINV. 1825. D. S. N. O., p. 92.
" " ! BLAINV. 1834. Actin., p. 229.
" " DESML. 1837. Syn., p. 288.
Tripneustes " ! AGASS. 1847. C. R. Ann. Sc. Nat., VI. p. 363. Zanzibar.
" " ! DUJ. HUPÉ, 1862. Échin., p. 534.
" " ! PERRIER, 1869. Pédic., p. 155., *Pl. V. f. 5a, c.*
Echinus **fasciatus** ! LAMK. 1816. An. s. Vert., p. 45. Isle de France.
" *fasciatus* ! BLAINV. 1834. Actin., p. 229, *Pl. XX. f. 4.*

Hipponoë variegata (*continued*).

Echinus fasciatus DESML. 1837. Syn., p. 288.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 9.
Tripneustes " ! DUJ. HUPÉ, 1862. Échin., p. 533.
Echinus **virgatus** ! ? LAMK. 1816. An. s. Vert., p. 44.
" *virgatus* BLAINV. 1834. Actin., p. 229.
" " DESML. 1837. Syn., p. 286.
" **inflatus** ! BLAINV. 1825. Dict. Sc. N. O., p. 91.
" **Peronii** ! BLAINV. 1825. Dict. Sc. N. O., p. 92.
" *Peronii* ! BLAINV. 1834. Actin., p. 229.
" " DESML. 1837. Syn., p. 228.
Tripneustes Peronii ! PERRIER, 1869. Echin., p. 157.
" **bicolor** ! VAL. PERR., 1869. Pédic., p. 156, *Pl. V. f. 6 a, b, c.*
" **fuscus** ! MICH. 1862. MAILLARD, Bourbon Annéx. A, p. 5. Bourbon.
" **zigzag** ! MICH. 1862. MAILLARD, Bourbon Annéx. A, p. 5. Bourbon.
Hipponoë **violacea** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Sandwich and Kingsmills Islands.
" *violacea* ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 358. Japan. Loo Choo.
" **nigricans** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Society Islands.
Tripneustes **Senkenbergianus** TROSCH. MS. (Mus. Frankft.),

*Sandwich, *Kingsmills, *Society Islands (Garrett); *Ousima (W. Stimpson, Smithson. Coll.); *Indian Ocean; *Tor, Red Sea (Mus. Vienna); *Zanzibar (Cheney); *Mozambique (Cook); *Mauritius (Pike); Bombay! Seychelles (J. d. P.); Nikobar! Amboina! (Mus. Copenh.); Samoa! (Ac. N. S. Phila.); Timor, Flores, Batyang, Moluccas (Martens); Reef of Omaga (Brit. Mus.); Philippine Islands! (Semper); Feejee Islands! Pelew Islands! (Mus. Godeff.).

(AMBLYPNEUSTES.) HOLOPNEUSTES.

Holopneustes AGASS. 1841. Anat. Genre Ech., VAL.
Holopneustes AGASS. 1846. C. R. Ann. Sc. Nat., VI.
Amblypneustes LÜTK. 1864. Bid. (pars.)

Holopneustes inflatus

Amblypneustes **inflatus** LÜTK. MS. 1872, in A. AGASS. Bull. M. C. Z., III. p. 18. Australia.
Holopneustes inflatus A. AGASS. 1872. Bull M C. Z., III. p. 18.

*M. C. Z.; New Holland! (Mus. Copenh.).

Holopneustes porosissimus

Cidaris granulata ! (**Ag.**) 1841. Int. Monog. An. Ech., VAL. (non LESKE).
Holopneustes *granulatus* ! AGASS. 1841. Int Monog. An. Ech., VAL. (non LESKE).
Holopneustes **porosissimus** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 364, *Pl. XV. f. 16.*
" *porosissimus* ! DUJ. HUPÉ, 1862. Échin., p. 536.

*M. C. Z., Australia (J. d. P.).

Holopneustes purpurescens

Amblypneustes **purpurescens** LÜTK. MS. 1872, in A. AGASS. Bull. M. C. Z., III. Australia.
Holopneustes purpurescens A. AGASS. 1872. Bull. M. C. Z., III.

*Hobart Town (Hamburg Mus.); *Australia, Murray Riv.! W. Australia (Brit. Mus.).

HOMOLAMPAS.

Lissonotus (**A. Agass.**) 1869. Bull. M. C. Z. (non SCHÖNH. 1817)
Homolampas.

Homolampas fragilis

Lissonotus **fragilis** ! A. AGASS. 1869. Bull. M. C. Z., I. 273. Straits of Florida.

*Off Bocca grande, 368 fms., *off Carysfort Reef, 320 fms. (Pourtalès); Josephine Bk ! 500–600 fms. (Mus. Stockholm).

LAGANUM.

Laganum KLEIN, 1734. Nat. Disp. Ech.
Echinodiscus LESKE, 1778. KL. Addit. (pars.)
Echinus GMEL. 1788. Syst. Nat. (pars.)
Clypeaster LAMK. 1816. An. s. Vert. (pars.)
Scutella LAMK. 1816. An. s. Vert. (pars.)
Lagana BLAINV. 1827. Dict. Sc. Nat.
Laganum AGASS. 1841. Mon. Scut.

Laganum Bonani

? ...... RUMPH, 1705. Amb. Rar. Kam., *Pl. XIV. f. E.* Amboina.
...... GUALTERI, 1742. Index Test., *Pl. CX. f. C.*
Echinus planus ...... SEBA, 1758. Thes., III. *Pl. XV. f. 25, 26.*
Laganum Bonani ! KLEIN, 1734. Nat. Disp. Ech., *Pl. XXII. f. a, b.*
Laganum Bonani ! AGASS. 1841. Mon. Scut., p. 108, *Pl. XXII. f. 25–29 ; Pl. XXIII. f. 8–12.* New Guinea. Vanikoro.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 12. Philippine Islands. Siguigor.
" " ! DESOR, 1855. Synop. Éch., *Pl. XXVII. f. 29, 30.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
" " MART. 1866. Wieg. Arch., I. p. 172. Java. Timor. Molucca.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XVI. f. 2.*
Echinodiscus **laganum** LESKE, 1778. KL. Add., *Pl. XXII. f. a, b.*
Echinus laganum GMEL. 1788. LINN. Syst. Nat., 3190.
Clypeaster laganum ! LAMK. 1816. An. s. Vert., p. 15.
Lagana " ! GRAY, 1825. Ann. Phil.
Lagana " ! BLAINV. 1834. Actin., p. 215.
Scutella " ! BLAINV. 1827. D. S. N., Art. Scut., p. 229.
" " ! DESML. 1837. Syn., p. 230.
Lagana minor ! GRAY, 1825. Ann. Phil., p. 6

*Tasmania (Liverpool Mus.); *Amboina (J. d. P.); New Guinea! Vanikoro! Australia! (J. d. P.); Siguigor! (Brit. Mus.); Philippine Islands! (Semper); Pelew Islands! (Mus. Godeff.); Java, Amboina, Molucca (Martens).

Laganum depressum

Laganum **depressum** ! LESS. 1841. AGASS. Mon. Scut., p. 110, *Pl. XXIII. f. 1–7.* Moluccas.
" *depressum* ! AGASS. 1847. C. R. Ann. Sc. Nat, VII. p. 132.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 10. Australia. Philippine Islands. Mauritius.
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 26. Kingsmills Islands.
" " ! MART. 1866. Wieg. Arch., I. p. 193. China. Makao.
" **Tonganense** ! QUOY et GAIM. 1841. AGASS. Mon Scut., p. 114, *Pl. XXVI. f. 7–19.* Tonga. New Guinea. Vanikoro.
" *Tonganense* ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
" **ellipticum** ! AGASS. 1841. Mon. Scut., p. 111, *Pl. XXIII. f. 13–15.*
" *ellipticum* ! GRAY, 1855. Cat. Rec. Ech., p. 12.
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
" **attenuatum** ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132. Red Sea. Persian Gulf.
" *attenuatum* ! GRAY, 1855. Cat. Rec. Ech., p. 10.
" **cingulatum** ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 133. Salomon Islands.
" *cingulatum* ! GRAY, 1855. Cat. Rec. Ech., p. 11.
" *scutiforme* ! DUJ. HUPÉ, 1862. Échin., p. 560.
Lagana **depressa** ! LESS. MS. (Mus. Paris.)
" **Tonganense** ! QUOY et GAIM. MS. (Mus. Paris.)

*Kingsmills Islands (Garrett) ; Tonga ! Amboina ! New Guinea ! Buru ! Moluccas ! Vanikoro ! Salomon Islands ! (J. d. P.) ; Salerno (Gray) ; Zanzibar ! (J. d. P., Mus. Copenh.) ; *Sandwich Islands (Pease) ; *So. Pacific ; New Caledonia ! (Crosse) ; Persian Gulf ! Waigiou ! Madagascar, Nos-Bé ! Darnley Islands ! Australia ! Siguigor ! Mauritius ! (Brit. Mus.) ; Philippine Islands ! (Semper) ; Feejee Islands ! (Mus. Godeff.) ; Makao (Martens).

Laganum Putnami

Laganum **Putnami** ! BARN. 1863, in AG. Proc. Ac. N. S. Phil., p. 359. Ousima.

*Ousima (W. Stimpson, Smithson. Coll.) ; *Japan (Salmin).

LINTHIA.

Desoria **(Gray)**, 1851. Ann. Mag. N. H., VII. p. 132 (non AGASS. 1841).
Linthia MER. 1853, in DES. Act. Soc. Helv.
Epiaster D'ORBIG. 1854. Pal. Franç. Terr. crét. (pars.)

Linthia australis

Desoria **australis** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 132. Flinder's Island.
" *australis* ! GRAY, 1855. Cat. Rec. Echin., p. 58, *Pl. VI. f. 2.* Van Diemen.
" **nodosa** ! VERRILL, 1869. Proc. Bost. Soc. N. H., XII. p. 382.

*Tasmania (B. M. Wright) ; *Australia ; Flinder's Island ! (Brit. Mus.).

LOVENIA.

Spatangus GRAY, 1845. EYRE, Voyage Discovery, I.
Lovenia AGASS. 1847. C. R. Ann. Sc. Nat, VIII.

Lovenia cordiformis

Lovenia **cordiformis** ! LÜTK. MS. 1872. A. AGASS. Bull. M. C. Z., III. San Diego. Guaymas.
" **Americana** ! A. AGASS. MS. (M. C. Z.)

*Guaymas, Gulf of California (Stone); San Diego! (Cassidy, Smithson. Coll.); Guayaquil! (Mus. Copenh.).

Lovenia elongata

...... AUDOUIN in SAVIGNY, Égypte, Zooph., *Pl. VII. f. 4.*
Spatangus **elongatus** GRAY, 1845, in EYRE, Voy., I. p. 436, *Pl. VI. f. 2.* Australia.
Lovenia elongata ! GRAY, 1851. Ann. Mag. N. H., p. 131. Port Western.
" " ! GRAY, 1855. Cat. Rec. Echin., p. 45.
Lovenia hystrix ! DES. 1847. AG. C. R. Ann. Sc. Nat., VIII. p. 11, *Pl. XVI. f. 16.* Red Sea.
Lovenia hystrix ! GRAY, 1855. Cat. Rec. Ech., p. 45.
" " ! DUJ. HUPÉ, 1862. Échin., p. 606, *Pl. IX. f. 11.*

*Red Sea; *Zanzibar (Webb, Cheney, Cook); Port Essington, W. Australia! (Brit. Mus.); Philippine Islands! (Semper).

Lovenia subcarinata

Spatangus **subcarinatus** GRAY, 1845. EYRE, Voyage, I. p. 436. Philippine Islands.
Lovenia subcarinata ! GRAY, 1851. Ann. Mag. N. H., p. 131.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 45, *Pl. V. f. 3.* Luzon.
" " ! A. AGASS. 1863. Proc. Ac. N. S. Phila., p. 360.
" **triangularis** ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 360. Kagosima.

*China Seas (Salmin); Kagosima Bay! Hong Kong! (W. Stimpson, Smithson. Coll.); Philippine Islands, Luzon! (Brit. Mus., Semper); Honolulu! (Stockholm Mus.).

(SPATANGUS.) MARETIA.

Spatangus LESKE, 1778. KL. Addit. (pars.)
" LAMK. 1816. An. s. Vert. (pars)
Maretia GRAY, 1855. Cat. Rec. Echin.
Hemipatagus MICH. 1862. MAILLARD Bourbon, An. A.
Lovenia PERRIER, 1869. Pédic. (pars.)
Hemipatagus DES. 1858. Syn. Éch. foss.
Thrichoproctus AGASS. MS. (M. C. Z.)
Plagiopatagus LÜTK. MS. in litt.

Maretia alta

Maretia **alta** ! A. AGASS. 1863. Proc. Ac. N. S. Phil., p. 360. Kagosima.

*Kagosima Bay (W. Stimpson, Smithson. Coll.); *Formosa (Mus. Godeff.).

Maretia planulata

...... SEBA, 1725. Thes., III. *Pl. XV. f. 27, 28*, copied in E. M., *Pl. CLIX. f. 5, 6.*
Spatangus **ovatus** LESKE, 1778. KL. Add., *Pl. XLIX. f. 12, 13* (non LAMK. nec KLEIN).
" **planulatus** ! LAMK. 1816. An. s. Vert., p. 31. So. Pacific.
" *planulatus* ! BLAINV. 1825. Dict. S. N., L. p. 91.
" " ! AGASS. 1836. Prod., p 17.
" " DESML. 1837. Syn., p. 378.
" " ! MICH. 1845. Rev Mag. Zool., p. 9. Isle de France.
" " ! AGASS 1847. C. R. Ann. Sc Nat., VIII. p. 7. Java. Waigiou.
" " ! DUJ. HUPÉ, 1862. Échin., p. 608.
" " MART. 1866. Wieg. Arch., I. p. 180. Molucca.
" " ! MART. 1867. Wieg. Arch., I. p. 113, *Pl III. f. 4.*
" " ! PERRIER, 1869. Pédic., p. 180, *Pl. VII. f. 7 a, c.*
Maretia *planulata* ! GRAY, 1855. Cat. Rec. Echin., p 48. Masbate. Borneo.
Maretia " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 27. Kingsmills Islands.
Hemipatagus **mascareignarum** ! MICH. 1862. MAILLARD, Bourbon An. A, p. 6, *Pl. XVI. f. 2.* Bourbon.
Maretia **variegata** ! GRAY, 1866. Proc. Zool. Soc. Lond., p. 170, *f.*
Lovenia **quadrimaculata** ! VAL. 1869. in PERRIER, Pédic., p. 178.
Thrichoproctus tenuis ! AGASS. MS. Mus. Comp. Zoöl.
Plagiopatagus *variegatus* ! LUTK. MS. in Litt.

*Waigiou ; *Kingsmills Islands (Garrett) ; *China Seas, *Java (Liverpool Mus.) ; *Bourbon (Maillard, Cotteau) ; *Siam (Salmin) ; *New Caledonia (Crosse) ; Masbate ! Borneo ! (Brit. Mus.) ; Philippine Islands (Semper) ; Banca Straits ! (Salmin) ; Molucca (Martens).

MELLITA.

Mellita KLEIN, 1734. Nat. Disp. Ech. (pars.)
Echinodiscus LESKE, 1788. KL. Addit. (pars.)
Clypeaster LAMK. 1816. An. s. Vert. (pars.)
Scutella LAMK. 1816. An. s. Vert. (pars.)
Mellita AGASS. 1841. Monog. Scut.
Leodia GRAY, 1851. Proc. Zool. Soc. London.
Encope AGASS. 1841. Mon. Scut. (pars.)
Echinoglycus GRAY, 1855. Cat. Rec. Ech. (pars.)

Mellita erythrea

Mellita **erythrea** ! GRAY, 1851. P. Z. S. L., p. 36. Red Sea.
" **sp.** ! A. AGASS. 1863. Proc. A. N. S. Phil., p. 359.

Red Sea ! (J. d. P. Brit. Mus.).

Mellita longifissa

Mellita **longifissa** ! MICH. 1858. R. M. Z., No. 8.
" *longifissa* ! DUJ. HUPÉ, 1862. Échin., p. 567, *Pl. IX. f. 6.*
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 26. Panama.
" " ! VERRILL, 1869. Proc. N. H. S. Boston, p. 383. Nicaragua.
" " ! VERRILL, 1871. Notes Radiata, p. 588. La Paz.

*Panama (Adams, Maack) ; *Acapulco (A. Agassiz) ; La Paz ! Acajutla ! (Yale Coll.).

Mellita pacifica

Mellita **pacifica** ! VERRILL, 1867. Notes on Radiata, p. 313. Zorritos.

Zorritos, Peru ! (Yale Coll.).

Mellita sexforis

...... SEBA, 1758. Thes., III. *Pl. XV. f. 7, 8.*
...... KNORR, 1771. Délic., *Pl. DI. f. 17.*
Echinodiscus **sexiesperforatus** LESKE, 1778. KL. Add., p. 135, *Pl. L. f. 3, 4*, copied in Enc. Méth., *Pl. CXLIX. f. 1, 2.*
Echinus **hexaporus** GMEL. 1788. LINN. Syst. N., 3189.
Scutella hexapora ! BLAINV. 1834. Actin., p. 219.
" " ! AGASS. 1836. Prod., p. 188.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XV. f. 1.*
Scutella sexforis ! LAMK. 1816. An. s. Vert., p. 9. Ocean Ind. et Americ.
Scutella sexforis ! BLAINV. 1827. D. S. N. Scut., p. 223.
" " DESML. 1837. Syn., p. 224.
Mellita hexapora ! AGASS. 1841. Mon. Scut., p. 41, *Pl. IV. f. 4–7; Pl. IV a. f. 11, 12.* Martinique. Mexico.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 23. St. Vincent Island.
" " ! MICH. 1858. Rev. Mag. Zoöl., No. 8.
" " ! DUJ. HUPÉ, 1862. Échin., p. 566, *Pl. X. f. 11, 12.*
" " ! LÜTK. 1864. Bid., p. 109, *Pl. II. f. 3.* W. Indies.
" **similis** ! AGASS. 1841. Mon. Scut., p. 43, *Pl. IV. f. 1–3.* Porto Rico.
" *similis* ! MICH. 1858. Rev. Mag. Zoöl., No. 8.
" " ! DUJ. HUPÉ, 1862. Échin., p. 567.
? *Scutella* **caroliniana** ! RAV. 1842. J. Ac. N. S. Phila., p. 333.
? *Mellita caroliniana* ! MCCRADY, 1857. Plio. Foss. So. Ca., *Pl. V. f. 4.*
Leodia Richardsonii ! GRAY, 1851. Proc. Zoöl. Soc. Lond., p. 36.
Leodia Richardsonii ! GRAY, 1855. Cat. Rec. Ech., p. 19.

*West Indies; *Charleston, S. C.; *Bermudas (Hill); *Florida, *Cuba (Arango); *Rebecca Shoal, 11 fms., *Double Head Shot Key, 4–6 fms., *Salt Key, *off Cherura, 270 fms. (Pourtalès); Martinique! Mexico! Porto Rico! St. Vincent! (Brit. Mus.).

Mellita Stokesii

Encope **Stokesii** ! AGASS. 1841. Mon Scut., p. 59, *Pl. VI a. f. 1–8.* Galapagos.
" *Stokesii* ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 137. Guayaquil.
" " ! DUJ. HUPÉ, 1862. Échin., p. 569.
" " ! LÜTK. 1864. Bid., p. 133. Punta Arenas.
Echinoglycus Stokesii ! GRAY, 1855. Cat. Rec. Ech., p. 27.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 26. Panama.
" " VERRILL, 1867. Notes Radiata, p. 312.

*Panama (Adams, Maack, Bradley, Yale Coll.); Punta Arenas! Guayaquil! Galapagos! (Mus. Copenh.).

Mellita testudinata

Mellita testudinata ! KLEIN, 1734. Nat. Disp. Ech., *Pl. XXI. f. C, D*, copied in Enc. M., *Pl. CXLIX. f. 3, 4.*
Mellita testudinata ! AGASS. 1841. Mon. Scut., p. 40, *Pl. IV a. f. 7–9.* Vera Cruz.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138.
" " ! MICH. 1858. Rev. Mag. Zoöl., No. 8.
" " ! DUJ. HUPÉ, 1862. Échin., p. 566.
...... GUALTERI, 1742. *Pl. CX. f. E.*
...... SEBA, 1758. Thes., III. *Pl. XV. f. 9, 10.*
...... KNORR, 1771. Délic., *Pl. DI. f. 16.*

Mellita testudinata (*continued*).

? *Echinus* **orbiculus** LINN. 1758. Syst. Nat., Ed. X. p. 666.
Echinodiscus **quinquiesperforatus** ! LESKE, 1778. KL. Add., p. 133, *Pl. XXI. f. C, D.*
Echinus **pentaporus** GMEL. 1788. LINN. Syst. N., 3189.
Clypeaster pentaporus ! LAMK. 1801. An. s. Vert., p. 349.
Scutella pentapora ! BLAINV. 1834. Actin., p. 219.
" " ! AGASS. 1836. Prod., p. 188.
Encope " ! AGASS. 1841. Mon. Scut., *Pl. III.*
Mellita " ! LÜTK. 1864. Bid., p. 107.
Scutella quinquefora ! LAMK. 1816. An. s. Vert., p. 9.
Scutella quinquefora ! BLAINV. 1827. D. S. N. Scut., p. 223.
" " ! DESML. 1837. Syn., p. 224.
Mellita " ! AGASS. 1841. Mon Scut., p. 36, *Pl. III.* So. Carolina. Porto Rico.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138. Cuba.
" " MICH. 1858. Rev. Mag. Zool., No. 8.
" " ! BRONN, 1859. KL. u. Ord. Actin, *Pl. XXXIX. f. 15.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 566.
? " **ampla** ! HOLMES, 1848. in RAV. Ech. So. Carolina.
? " *ampla* ! HOLMES, 1860. Post. Pl. Foss. So. Ca., *Pl. I. f. 6.*
" **testudinaria** GRAY, 1851. Proc. Zool. Soc. Lond
" **testudinea** ! GRAY, 1855. Cat. Rec Ech., p. 22. Brazil.

*Itabapuana, *Rio Doce (Hartt, Copeland, Thayer Exp.); *Marañhao (Agassiz, Thayer Exp.); *Cumana, Venez. (Couthouy); *Jamaica (Adams); Cuba! (Arango); Porto Rico! Vera Cruz! (J. d. P.); *Texas (Stolley); *Captiva Key, *Key Biscayne, Fla. (Würdeman); *Amelia Island, Fla. (Scudder); *Florida, 7 fms. (Pourtalès); *Savannah, *Charleston, S. C., Nantucket! (Agassiz); *Beaufort, N. C. (Stimpson, Bickmore); *Hogg Island, Va. (Stimpson); Vineyard Sound (Verrill).

(BRISSUS.) MEOMA.

Spatangus LAMK. 1816. An. s. Vert. (pars.)
Brissus GRAY, 1825. Ann. Phil. (pars.)
Schizaster D'ORBIG. 1847. AGASS. C. R. Ann. Sc. Nat. VIII.
Meoma GRAY, 1851. Ann Mag. N. H. VII.
Periaster DUJ. HUPÉ, 1862. Échin. (pars.)
Kleinia A. AGASS. 1863. Bull. M. C. Z., I.
Rhyssobrissus A. AGASS. 1863. Bull. M. C. Z., I.
Hemibrissus POMEL, 1869. Revue des Échinod.
Breynia PERRIER, 1869. Pédic. (pars.)

Meoma grandis

Meoma grandis ! GRAY, 1851. Ann. Mag. N. H., VII. p. 132. Australia ? ?
Meoma grandis ! GRAY, 1855. Cat. Rec. Echin., p. 56, *Pl. V. f. 2.*
" *nigra* ! VERRILL, 1867. Notes Radiata, p. 317.
" " VERRILL, 1871. Notes Radiata. La Paz. Gulf of California.
Kleinia **nigra** ! A. AGASS. 1863. Bull. M. C. Z., I. p. 27. Acapulco.
Rhyssobrissus *niger* ! A. AGASS. 1863. Bull. M. C. Z., I. p. 27.
Breynia nigra ! PERRIER, 1869. Pédic., p. 174.

*Acapulco (Van Brunt, A. Agassiz); La Paz! (Yale Coll.); *Gulf of California (Stone); *Mexican coast; Cape St. Lucas! (Xanthus, Smithson. Coll.).

Meoma ventricosa

Spatangus **ventricosus** ! LAMK. 1816. An. s. Vert., p. 29. Antilles.
" *ventricosus* BLAINV. 1834. Actin., p. 203.
Brissus " ! GRAY, 1825. Ann. Phil., p. 9.
" " ! AGASS. 1836. Prod., p. 184.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat. VIII., p. 13.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 54.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.
Meoma ventricosa ! LÜTK. 1864. Bid., p. 120.
Schizaster **cubensis** ! D'ORBIG. 1847, in AGASS. C. R. Ann. Sc. Nat., VIII. p. 22 (non A. AGASS.).
Periaster *cubensis* ! D'ORBIG. 1854. Pal. fr., p. 270.
Brissus **panis** ! GRUBE, 1857. Wieg. Arch., p. 344.
" *panis* ! GRUBE, 1857. Nov. Act., p. 47, *Pl. III. f. 5, 6.*
" **spatiosus** MCCRADY, 1857. Plio. foss. So. Ca., p. 8, *Pl. III. f. 1.*
Hemibrissus *ventricosus* POMEL, 1869. Rev. d. Échinod., p. XIII.

*W. Indies; *Florida Reef, *Tortugas, *off Tennessee Reef, 85, 115 fms. (Pourtalès); Honduras! (Mus. Copenh.); Guadeloupe! (J. d. P.).

MESPILIA.

Cidaris KLEIN, 1734. Nat. Disp. Echin. (pars.)
Echinus LINN. 1758. Syst. Nat. (pars.)
Microcyphus AGASS. 1841. Introd. Monog. Scut. (non AGASS. 1846).
Mespilia AGASS. 1846. C. R. Ann. Sc. Nat. VI.

Mespilia globulus

Cidaris *assulata granulata* KLEIN, 1734. Nat. Disp. Ech., *Pl. X. f. E, F.*
Cidaris **granulata** LESKE, 1778. *Pl. X. f. E, F.*
Echinus **globulus** LINN. 1758. Syst. Nat. Ed. X.
" *globulus* GMEL. 1788. LINN. Syst. N.
" " ! BLAINV. 1825. Dict. Sc. N. O., p. 82.
" " ! ENC. MÉTH. *Pl. CXLII. f. 1, 2.*
" " BLAINV. 1834. Actin., p. 227.
" " DESML. 1837. Syn., p. 274.
Mespilia " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 358, *Pl. XV. f. 17.* Tonga Tabu.
Mespilia " ! DUJ. HUPÉ, 1862. Échin., p. 517.
" " ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 358. Ousima.
" " ! STEWART, 1865. Trans. Lin. Soc., XXV. *Pl. L. f. 8.*
Echinus **versicolor** ! VAL. 1841, in AGASS. Monog. Scut., p. 7.
Microcyphus *versicolor* ! AGASS. 1841. Monog. Scut., p. 7.
Microcyphus " ! DUJ. HUPÉ, 1862. Échin., p. 517.
Mespilia **Verrauxi** ! MICH. M.S. (Écol. Min.)

*Ousima (Stimpson, Smithson. Coll.); *Tonga Tabu; *Samoa (Mus. Godeff.); China! (Mus. Copen.); Philippine Islands! (Semper); Sandwich Islands! (Mus. Godeff.).

(BRISSUS.) METALIA.

Spatangus KLEIN, 1734. Nat. Disp. Echin. (pars.)
Brissus AGASS. 1836. Prod. (pars.)
Plagionotus (**Agass.**) 1847. C. R. Ann. Sc. Nat., VIII. (non MULS. 1842).
Metalia GRAY, 1855. Cat. Rec. Ech.
Xanthobrissus A. AGASS. 1863. Bull. M. C. Z.
Bryssus MARTENS, 1869. Decken's Reise.
Leiopatagus POMEL, 1869. Int. Rev.

Metalia africana

Plagionotus **africanus**! VERRILL, 1871. Notes Radiata, p. 569. Sherboro Island. W. Africa.

Sherboro Island! (Yale Coll.).

Metalia maculosa

...... RUMPH. 1705. Amb. Rar. Kam., *Pl. XIV. f. I.* Amboina.
...... GUALTERI, 1742. Ind. Test., *Pl. CIX. f. A.*
...... SEBA, 1758. Thes. III. *Pl. X. f. 22, a, b,* copied in Enc. Méth., *Pl. CLVIII. f. 7, 8.*
Spatangus *Brissus maculosus angustus*! KLEIN, 1734. Nat. Disp. Ech., *Pl. XXIV. f. A, B.*
Spatangus " " LESKE, 1778. KLEIN, Add., *Pl. XXIV. f. A, B.* (pars.)
Echinus **maculosus** GMEL. 1788. LINN. Syst. N., 3199.
Spatangus maculosus BLAINV. 1829. Dict. Sc. Nat., L. p. 92.
" " DESML. 1837. Syn., p. 382.
Brissus " MART. 1866. Wieg. Arch., I. p. 181.
Spatangus **compressus**! LAM. 1816. An. s. Vert., p. 30. Isle de France.
Spatangus compressus DESML. 1837. Syn., p. 388.
Brissus compressus! AGASS. 1836. Prod., p 18.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 7.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 13.
" " ! GRAY, 1855. Cat. R. Ech., p. 53.
" " ! DUJ. HUPÉ, 1862. Échin., p 606.
" " ! MART. 1866. Wieg. Arch., I. p. 183. Mozambique.
Metalia **nobilis**! VERRILL, 1867. Notes Radiata, p. 319. Cape St. Lucas. Panama.
" *nobilis*! VERRILL, 1871. Notes Radiata, p. 591.
Plagionotus nobilis! A. AGASS. 1869. Bull. M. C. Z., I. p. 302.
" **timorensis** MICH. MS. (Écol. Min.).

*Samoa (Mus. Godeff.); *Sandwich, Kingsmills, and Society Islands (Garrett); Philippine Islands! (Semper); Timor, Flores, New Holland (Martens); Isle de France! Bourbon! (J. d. P.); Panama! (Bradley, Yale Coll.); Cape St. Lucas! (Smithson. Coll.).

Metalia pectoralis

Echinanthus maximus ...... SEBA, 1758. Thes., III. *Pl. XIV. f. 5, 6,* copied in Enc. Méth., *Pl. CLIX. f. 2, 3.*
Echinus **grandis** GMEL. 1788. LINN. Syst. N.
Spatangus **pectoralis**! LAMK. 1816. An. s. Vert., p. 29.
" *pectoralis* DESLONG. 1824. E. M., II. p. 686.
" " ! BLAINV. 1829. Dict. Sc. N., L. p. 88.
" " ! BLAINV. 1834. Actin., p. 203.
" " DESML. 1837. Syn., p. 380.
Brissus " ! AGASS. 1836. Prod., p. 184.
Plagionotus pectoralis! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 13, *Pl. XVI. f. 15.* Mexico. Bahia.

Metalia pectoralis (*continued*).

Plagionotus pectoralis ! GRAY, 1855. Cat. Rec. Ech., p. 50.
" " ! DUJ. HUPÉ, 1862. Échin., p. 606.
" " ! LÜTK. 1864. Bid., p. 122.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 275. Straits of Florida.
" " ! PERRIER, 1869. Pédic, p. 178.
" " ! VERRILL, 1871. Notes Radiata, p. 571.
Eupatagus " D'ARCH. HAIME, 1854. An. foss. Inde, p. 217.
Plagionotus **Desorii** ! GRAY, 1855. Cat. Rec. Echin., p. 51.
" *Desorii* ! DUJ. HUPÉ, 1862. Échin., p. 606.
" " ! PERRIER, 1869. Pédic, p. 178.
" ? **Holmesii** McCRADY, 1857. Plioc. foss. So. Ca., p. 9, *Pl. III. f. 2.*
" **Ravenellianus** McCRADY, 1857. Plioc. foss. So. Ca., p. 9, *Pl. III. f. 3.*

*Tampa Bay (W. Stimpson); *W. India Islands; Mexico! (Mus. Copenh.); Littoral, fragments 115 fms. Florida Gulf Stream (Pourtalès).

Metalia sternalis

Spatangus *Brissus maculosus ventricosus* ! KLEIN, 1734. Nat. Disp. Ech., *Pl. XXVI. f. A.*
Spatangus " " LESKE, 1778. KL. Add., *Pl. XXVI. f. A.* (pars.)
...... GUALTERI, 1742. Ind. Test., *Pl. CIX. f. B; Pl. CVIII. f. G.*
Spatangus **sternalis** ! LAMK. 1816. An. s. Vert., p. 31. So. Pacific.
" *sternalis* DESML. 1837. Syn., p 388.
" " ! AGASS. 1836. Prod., p. 184.
Brissus " ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII., p. 13.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.
" " ! MART. 1866. Wieg. Arch., I. p. 182. Red Sea.
Bryssus " ! MART. 1869. Decken's Reise, p. 128, *Pl. I. f. 1.* Zanzibar.
Metalia " GRAY, 1855. Cat. Rec. Ech., p. 51. Mauritius.
Brissus **bicinctus** ! VAL. 1847. C. R. Ann. Sc. Nat, VIII. p. 13. Red Sea.
" *bicinctus* ! GRAY, 1855. Cat Rec. Ech., p. 55.
" " ! DUJ. HUPÉ, 1862. Échin., p. 605.
" **areolatus** ! VAL. 1847 in AGASS. C. R. Ann. Sc. Nat., VIII. p. 13. So. Pacific.
" *areolatus* ! GRAY, 1855. Cat. Rec. Ech., p. 53.
" " ! DUJ. HUPÉ, 1862. Échin., p. 606.
Xanthobrissus Garetti ! A. AGASS. 1863. Bull. M. C. Z., I. p. 28. Kingsmills Islands.
Metalia Garetti ! VERRILL, 1867. Notes Radiata.

*Sandwich, *Kingsmills, *Society Islands (Garrett); *Samoa Islands (Mus. Godeff.); *Mauritius (Pike); *Zanzibar (Cheney); South Sea! Isle de France! Bourbon! (J. d. P.); Raines' Inlet! Port Essington! Reef Attagor! Luzon! Osmaga! (Brit. Mus.); Timor, Flores, New Holland (Martens); Philippine Islands! (Semper); New Caledonia! (Crosse); *Red Sea; Siam! (Bonn Mus.); Upolu! (Mus. Godeff.).

MICROCYPHUS.

Cidaris KLEIN, 1734. Nat. Disp. Ech. (pars.)
Microcyphus AGASS. 1841. Anat. Genre Ech. (non AGASS. 1841, Mon. Scut.). (pars.)
Anthechinus A. AGASS. 1863. Proc. A. N. S. Phila.

Microcyphus maculatus

...... GUALTERI, 1742. Index Test., *Pl. CVIII. f. A.*
Microcyphus **maculatus** ! AGASS. 1841. Anat. Genre Ech., p. VIII.
" *maculatus* ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 358.
" " ! DUJ. HUPÉ, 1862. Échin., p. 517.
Microcyphus **Rousseaui** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. *Pl. XV. f. 10.* Mascate.
" *Rousseaui* ! DUJ. HUPÉ, 1862. Échin., p. 517.
Anthechinus roseus ! A. AGASS. 1863. Proc. Ac. N. S. Phila., p. 358. Japan.

Ousima (Stimpson, Smithson. Coll.); *Navigator Islands (Hamburg Mus.); Mascate! Mayotte Island! (J. d. P.); Australia! (Liverpool Mus.); Molucca (Martens).

Microcyphus zigzag

? **Cidaris bothryoides** KLEIN, 1734. Nat. Disp. Ech., *Pl. XI. f. H* (non AGASS. P. both.).
Microcyphus **zigzag** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 358.
" *zigzag* ! DUJ. HUPÉ, 1862. Échin., p. 517.

*Philippine Islands; *New Holland (Hamburg Mus.); West Australia! Tasmania! (Brit. Mus.).

(SCHIZASTER.) MOIRA.

Spatangus LAMK. 1816. An. s. Vert. (pars.)
Echinocardium GRAY, 1825. Ann. Phil. (pars)
Schizaster AGASS. 1836. Prod. (pars.)
Moera (**Mich.**) 1855. Rev. Mag. Zoöl. non LEACH nec HÜBN.
Moira.

Moira atropos

...... KNORR, 1771. Délic., *Pl. DIII. f. 3.*
...... ENC. MÉTH, *Pl. CLV. f. 9, 11.*
Spatangus **atropos** ! LAMK. 1816. An. s. Vert., p. 32.
" *atropos* ! BLAINV. 1834. Actin., p. 202.
" " DESML. 1837. Syn., p. 384.
Echinocardium *atropos* ! GRAY, 1825. Ann. Phil., p. 8.
Schizaster " ! AGASS. 1836. Prod., p. 18.
Schizaster " ! AGASS. 1847. C R. Ann. Sc. Nat., VIII. p. 22, *Pl. XVI. f. 10.* So. Carolina.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 61.
Moera atropos ! MICH 1855. Rev. Mag. Zoöl., p. 246.
" " ! DUJ. HUPÉ, 1862. Échin., p. 603.
" " ! A. AGASS. 1863. Bull. M. C. Z., I.
" " ! LÜTK. 1864. Bid., p. 55. W. Indies.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 296. Straits of Florida.
" " ! PERRIER, 1869. Pédic., p. 178.
Schizaster **Lachesis** ! GIR. 1850. Proc. Boston S. N. H, p. 368. Texas.
Moera Lachesis ! MICH. 1855. Rev. Mag. Zoöl., p. 247.
" " ! DES. 1855. Syn. Éch. foss., p. 394.
" " ! DUJ. HUPÉ, 1862. Échin., p. 603.
" " ! PERRIER, 1869. Pédic., p. 178.

*Texas; *Florida (Würdemann); *Charleston, S. C. (Agassiz, Gibbes); *Beaufort, N. C. (Bickmore); Guadeloupe! (Duchassaing, J. d. P.); Littoral to 80 fms. Florida Gulf Stream (Pourtalès).

Moira clotho

Moera **clotho** ! MICH. 1855. Rev. Mag. Zoöl., p. 247. Mazatlan.

*Mazatlan (Cotteau) ; Guayamas ! (Mus. Copenh.) ; *Gulf California (École Min.)

Moira stygia

Moera **stygia** ! LÜTK. MS. 1872, in A. AGASS., Bull. M. C. Z., III. Red Sea.

*Red Sea ; Zanzibar ! (Mus. Copenh.).

NEOLAMPAS.

Neolampas A. AGASS. 1869. Bull. M. C. Z., I.

Neolampas rostellata

Neolampas rostellatus ! A. AGASS. 1869. Bull. M. C. Z., I. p. 271. Straits of Florida.

*Off Sand Key, Florida, 112 fms., *off Samboes, 125 fms. (Pourtalès).

(ECHINOBRISSUS.) NUCLEOLITES.

Nucleolites EDW. 1836. CUV. Règ. An. Ed. Ill.
Echinobrissus DUJ. HUPÉ, 1862. Échin.
Echinobrissus D'ORBIG. 1854. Rev. Mag. Zoöl. (pars.)
Nucleolites DESOR, 1857. Syn. Éch. foss.
Nucleolus MART. 1866. Wieg. Archiv.

Nucleolites epigonus

Nucleolites **epigonus** ! MART. 1865. Monatsb. Ak. Berlin, März., p. 143. Flores.
Nucleolus *epigonus* ! MART. 1866. Wieg. Arch , p. 179.
" " MART. 1867. Wieg. Arch., I. *Pl. III. f. 13.*

*M. C. Z. ; Flores, Java, Timor ! (Martens) ; Lord Hood's Island ! (Brit. Mus.).

PALEOSTOMA.

Leskia (**Gray**) 1851. Ann. Mag. N. H., VII (non ROB. DES. 1830.)
Paleostoma LOVÉN, 1867. Vetensk. Ak. Förhdl.

Paleostoma mirabilis

Leskia **mirabilis** ! GRAY, 1851. Ann. Mag N. H., VII. p. 134. Luzon.
Leskia mirabilis ! GRAY, 1855. Cat. Rec. Ech., p. 63, *Pl. IV. f. 4.*
" " DUJ. HUPÉ, 1862. Échin., p. 600.
" " ! A. AGASS. 1863. Proc. A. N. S. Phila., p. 360.
Paleostoma *mirabilis* ! LOVÉN, 1867. Vetensk. Ak. Förhdl., No. 5, p. 432, *f. 1, 2.* Singapore.

*Singapore, Batavia (Kinberg, Mus. Stockh.) ; Hong Kong ! (W. Stimps., Smithson. Coll.) ; Luzon ! (Brit. Mus.).

(ECHINOMETRA.) PARASALENIA.

Parasalenia A. AGASS. 1863. Bull. M. C. Z., I.
Echinometra LÜTK. 1864. Bid. (pars.)
Cladosalenia A. AGASS. MS.

Parasalenia gratiosa

Parasalenia gratiosa! A. AGASS. 1863. Bull. M. C. Z., I. p. 22. Kingsmills and Society Isl'ds.
Echinometra **arbacia**! LÜTK. 1864. Bid., p. 152, *Pl. I. f. 9.*

*Kingsmills Islands, *Society Islands (Garrett); *Bouin Islands (Stimpson, Smithson. Coll.); *New Caledonia (Crosse); ? New Guinea! (Mus. Copenh.); Tongatabu! (Mus. Godeff.); *Zanzibar (Cooke); *Feejee Islands (Mus. Godeff.).

(LAGANUM.) PERONELLA.

Scutella BLAINV. 1827. Dict. S. N. Scut. (pars.)
Lagana LESS. 1834, in BLAINV. Actin. (pars.)
Laganum LESS. 1841, in AGASS. Mon. Scut. (pars.)
Peronella GRAY, 1855. Cat. Rec. Echin.
Rumphia DES. 1857. Syn. Éch. foss
Polyaster MICH. 1859. Rev. Mag. Zoöl. (non GRAY, 1840).
Michelinia DUJ. HUPÉ, 1862. Échin. (non KON. 1842).
Rumphia A. AGASS. 1863. Bull. M. C. Z.

Peronella decagonalis

Scutella **decagonalis**! LESS. 1827. Dict. S. Nat. Scut., p. 229.
Lagana **decagona**! LESS. 1834, in BLAINV. Actin., p. 215, *Pl. XVIII. f. 3.*
" *decagona*! EDW. in CUV. Règ. An. Ed Ill., *Pl. XV. f. 4.*
" " DESML. 1837. Syn., p. 230.
Laganum decagonum! LESS. 1841. AGASS. Mon. Scut, 112, *Pl. XXIII. f. 16–20.*
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132. Waigiou.
" " ! GRAY, 1855. Cat. Ech., p. 12.
" " ! DUJ. HUPÉ. 1862. Éch., p. 560.
" " ! MARTENS, 1866. Wieg. Arch., p. 173. Makao.
Laganum **Lesueuri** VAL. 1841, in AGASS. Mon. Scut., p. 116, *Pl. XXIV. f. 3–6.*
" *Lesueuri*! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 9. China.
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
Rumphia " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 25. Hong Kong.
Polyaster **elegans**! MICH. 1859. Rev. Mag. Zoöl., No. 9, *Pl XIV. f. 1.*
Michelinia elegans! DUJ. HUPÉ, 1862. Échin., p. 561.
Laganum **elongatum** AGASS. 1841. Mon. Scut., p. 117, *Pl. XXIV. f. 1, 2.*
" *elongatum* AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
" " DUJ. HUPÉ, 1862. Échin., p. 560.
" **australe**! GRAY, MS., (Brit. Mus.)

*Hong Kong (Putnam); *New Caledonia (Crosse); Australia! Freemantle Bay! (Brit. Mus.); Japan! (Mus. Copenh.); Gaspar Straits! 12 fms. (Liverpool Mus.); Philippine Islands! (Semper); Bay of Bengal! (Berlin Mus.).

Peronella orbicularis

...... BREYN. 1732. *Pl. VI. f. 1, 2.*
Laganum *Schynoretti* ...... KLEIN, 1734. Nat. Disp. Ech., p. 125.
...... GUALTERI, 1742. *Pl. CX. f. B*, copied in Enc. Méth., *Pl. CXLVII. f. 1, 2.*
Echinodiscus **orbicularis** LESKE, 1778. KL. Add., p. 144, *Pl. XLV. f. 6, 7.*
" *orbicularis* GRAY, 1825. Ann. Phil., p. 11.
" " BLAINV. 1834. Actin., p. 218.
Echinus " GMEL. 1788. Syst. Nat.
Laganum orbiculare! AGASS. 1841. Mon. Scut., p. 120, *Pl. XXII. f. 16–20* (non Sc. orbic. LAMK.). Batavia.
" " ! AGASS. 1847. C. R. Ann. Sc Nat., VII. p. 132.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 11.
" " ! DUJ. HUPÉ, 1862. Échin., p. 560.
" **marginale**! AGASS. 1841. Mon. Scut., p. 121, *Pl. XXII. f. 11–15* (non Cat. Rais.).

*M. C. Z.; New Holland! (Mus. Copenh.); Formosa! (Mus. Godeff.).

Peronella Peronii

Laganum **Peronii**! AGASS. 1841. Mon. Scut., p. 123, *Pl. XXII. f. 21–24.* So. Pacific.
" *Peronii*! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
Peronella " ! GRAY, 1855. Cat. Rec. Ech., p. 13. New S. Wales.
Rumphia " DES. 1857. Syn. Éch. foss., p. 229.
Rumphia " ! DUJ. HUPÉ, 1862. Échin., p. 561.
Scutella orbicularis! (**Lamk.**) 1816. An. s. Vert., p. 11 (non Ech. orb. LESKE).
" " ! DESML. 1837. Syn., p. 232.
Lagana " ! BLAINV. 1827. Dict. Sc. N., p. 197 (non Lag. orb. AGASSIZ).
" " ! BLAINV. 1834. Actin., p. 215, *Pl. XVIII. f. 2.*
Laganum **stellatum**! AGASS. 1841. Mon. Scut., p. 122, *Pl. XXII. f. 7–10.* New S. Wales.
" *stellatum* GRAY, 1855. Cat. Rec. Echin., p. 9. Australia.
" " DUJ. HUPÉ, 1862. Échin., p. 560.

*Australia; *Philippine Islands (Liverpool Mus.); Tasmania! (Liverpool Mus.); Brisbane Water! (Brit. Mus.).

Peronella rostrata

Laganum **rostratum**! AGASS. 1841. Mon. Scut., p. 118, *Pl. XXV.*
" *rostratum*! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 132.
" " ! GRAY, 1855. Cat. Rec. Echin., p. 9. New Zealand.
" " ! DUJ. HUPÉ, 1862. Échin., p. 561.
Rumphia *rostrata* DESOR, 1857. Synops. Éch. foss., p. 229.

*M. C. Z.; New Zealand! Zanzibar! (J. d. P.).

(CIDARIS.) PHYLLACANTHUS.

Cidaris KLEIN, 1734. Nat. Disp. Echin. (pars.)
Cidarites LAMK. 1816. An. s. Vert. (pars.)
Phyllacanthus BRANDT, 1835. Prod. Descrip. (pars.)
Leiocidaris DES. 1854. Synops. Échin. foss.
Rhabdocidaris DES. 1854. Syn. Éch. foss.
Goniocidaris GRAY, 1855. Proc. Zoöl. Soc. London. (pars.)
Prionocidaris A. AGASS. 1863. Bull. M. C. Z., I.
Chondrocidaris A. AGASS. 1863. Bull. M. C. Z., I.

Phyllacanthus annulifera

Cidarites **annulifera**! LAMK. 1816. An. s. Vert., p. 57. New Holland.
" *annulifera* DESLONG. 1824. E. M, II. p. 196.
" " DESML. 1837. Syn., p. 326.
Cidaris " ! AGASS., 1836. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 327.
" " ! DUJ. HUPÉ, 1862. Éch., p. 471.
" " ! PERRIER, 1869. Pédic., p. 127.
" **ornata**!? GRAY, 1855. Proc. Zoöl. Soc. Lond., p. 37.
" **annulata**! GRAY, 1855. Proc. Zoöl. Soc., p. 37 (non A. AGASS.).
" **circinnata**! MART. 1866. (MS. Amst. Mus.) Wieg. Arch., p. 147. Malacca.
" **rosaceus**! ROUSSEAU, 1869, in PERRIER, Pédic., p. 129, *Pl. III. f. 9.* So. Pacific.

*Australia! (Liverpool Mus.); *M. C. Z.; Philippine Islands! (Semper); Malacca! Oceanie! (J. d. P.).

Phyllacanthus baculosa

Cidarites **pistillaris**! LAMK. 1816. An. s. Vert., p. 55. Isle de France.
" *pistillaris* DESLONG. 1824. E. M., *Pl. CXXXVII.*
" " DESML. 1837. Syn., p. 324.
Cidaris " AUDOUIN, Savigny Égypte Échin., *Pl. VII. f. 1.*
" " ! BLAINV. 1834. Actinol., p. 231.
" " ! AGASS. 1836. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 327. Seychelles.
" " ! DUJ. HUPÉ, 1862. Échin, p. 471.
Goniocidaris pistillaris! GRAY, 1855. Proc. Zoöl. Soc. Lond., p. 35.
Prionocidaris *pistillaris*! A. AGASS. 1863. Bull. M. C. Z., I. p. 18. Zanzibar.
Cidarites **baculosa**! LAMK. 1816. An. s. Vert., p. 55.
" *baculosa* DESML. 1837. Syn., p. 324.
" " ! MICH. 1845. Rev. Mag. Z., p. 16, *Pl. IV. f. 1–8.*
Cidaris " ! AGASS. 1836. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 327. Red. Sea.
" " ! DUJ. HUPÉ, 1862. Échin., p. 471.
" " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 17.
" " ! MART. 1866. Wieg. Arch., I. p. 144. Mozambique. Amboina Flores.
" " ! PERRIER, 1869. Pédic., p. 126, *Pl. III. f. 1, 3, 4.*
Cidarites **papillaris**! MICH. 1845. Rev. Mag. Zoöl., p. 16. Isle de France.
Cidaris **Lima**! VAL. 1846. AGASS. DES. C. R. Ann. Sc. Nat., VI. p. 327. Bourbon.
" *Lima*! DUJ. HUPÉ, 1862. Échin, p. 472.
" **Krohnii**! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 327. Seychelles.
" *Krohnii*! DUJ. HUPÉ, 1862. Échin., p. 472.

*Red Sea (Botta); *Tor (Frauenfeld); *Zanzibar (Cook); *Bourbon; *Isle de France; Mauritius! Seychelles! (J. d. P.).

Phyllacanthus dubia

Phyllacanthus dubia BRANDT, 1835. Prod., p. 268. Bonin.
Phyllacanthus dubia! A. AGASS. 1863. Proc. A. N. S. Phila., p. 353.
Cidarites " DESML. 1837. Syn., p. 326.
Phyllacanthus imperialis! A. AGASS. 1863. Bull. M. C. Z, I. p. 17 (non BRANDT.). N. Holland.
Cidaris **canaliculatus**! ROUSSEAU, 1869. PERRIER, Pédic., p. 189, *Pl. III. f. 5.* Red Sea.

*Zanzibar (C. Cook, Cheney, Ropes); *Bonin Islands (W. Stimpson); Red Sea! (J. d. P.); New Caledonia! (École. Min.); New Holland! (Phila. Acad.).

Phyllacanthus gigantea

Chondrocidaris gigantea! A. AGASS. 1863. Bull. M. C. Z., I. p. 18. Sandwich Islands.

*Sandwich Islands (Garrett).

Phyllacanthus imperialis

Cidaris Mauri ...... ! KLEIN, 1734. De Echin., *Pl. VII. f. A, B, C.*
Echinometra altera digitata SEBA, 1758. Thes., III. *Pl. XIII. f. 3.*
...... KNORR, 1771. Délic., *Pl. D. f. 2.*
Cidaris papillata major LESKE, 1778. KLEIN, Add., p. 126, *Pl. VII. f. A*, copied in DESLONG., Enc. Méth., *Pl. CXXXVI. f. 8; Pl. CXXXIX. f. 9.*
Echinus **cidaris** LIN. 1758. Syst. Nat. (pars.)
" *cidaris* GMEL. 1788. LIN. Syst. Nat., 3174. (pars.)
Cidarites **imperialis** ! LAMK. 1816. An. s. Vert., p. 54. Red Sea.
" *imperialis* DESML. 1837. Syn., p. 318.
Cidaris " ! GRAY, 1825. Ann. Phil., p. 4.
" " ! BLAINV. 1834. Actinol., p. 231.
" " ! AGASS. 1836. Prod., p. 21.
" " PHIL. 1845. Wieg. Arch., I. p. 353.
" " ! AGASS. 1846. Ann. Sc. Nat., VI. p. 326.
" " ! MART. 1866. Wieg. Arch., I. p. 147. Amboina. Molucca.
Phyllacanthus *imperialis* BRANDT, 1835. Prod., p. 268 (non A. AGASS.).
Leiocidaris " DES. 1854. Syn. Éch. foss., p. 48.
Leiocidaris " ! DUJ. HUPÉ, 1862. Échin., p. 482.
" " ! PERRIER, 1869. Pédic., p. 129.
Phyllacanthus **fustigera** ! BARN. 1863, in A. AGASS. Syn. Proc. A. N. S Phila., p. 353. Polar Seas.
Cidaris fustigera MART. 1866. Wieg. Arch.
" **Gaimardii** ROUSS. (MS. J. d. P.).

*Red Sea (J. d. P.); *Gaspar Straits (Stimpson, Smithson. Coll.); *E. India; New Holland! Aru Islands! (J. d. P.); Zanzibar! (Brit. Mus.); Tonga! (Mus. Godeff.); Sulu Sea! (U. S. Ex. Exped. Smithson. Coll.); Molucca (Amsterd. Mus. Martens).

Phyllacanthus verticillata

Cidarites **verticillata** ! LAMK. 1816. An. s. Vert., p. 56.
" *verticillata* DESLONG. 1824. Enc. M., *Pl. CXXXVI. f. 2, 3.*
" *verticillata* DESML. 1837. Syn., p. 324.
Cidaris " ! AGASS. 1836. Prod., p. 21.
" " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI p. 327. So. Pacific.
" " GRIFFITH, CUV. An. Kingd., *Pl. XIII. f. 1.*
" " ! GRAY, 1855. Proc. Zool. Soc. Lond., p. 37.
" " ! DUJ. HUPÉ, 1862. Échin., p. 472.
" " ! MART. 1866. Wieg. Arch., I. p. 141. Flores. Timor.
" " ! PERRIER, 1869. Pédic., p. 128, *Pl. III. f. 7.*

*Society Islands! (Garrett); *So. Seas (J. d. P.); *Samoa (Mus. Godeff.); *Lorentuka (Martens); Molucca! (Mus. Berl.); New Holland! (J. d. P.); Feejee! Sandwich Islands! (Mus. Godeff.); Mindoro! (Brit. Mus.).

PHYMOSOMA.

Cyphosoma (**Agass.**) 1840. Cat. Syst. Ectyp. (non MANN. 1837).
Phymosoma HAIME, 1853 D'ARCH. HAIME, An. foss. d'Inde.
Coptosoma DES. 1855. Synops. Éch. foss
Glyptocidaris A. AGASS. 1863. Proc. Acad. N. S. Phila.

Phymosoma crenulare

Glyptocidaris crenularis ! A. AGASS. 1863. Proc. Acad. N. S. Phila., p. 356. Hakodadi.

*Hakodadi (W. Stimpson, Smithson. Coll.).

PLATYBRISSUS.

Platybrissus GRUBE, 1865. Jahresb. d. Schles. Ges. f. Vaterl. Cult.

Platybrissus Roemeri

Platybrissus Roemeri! GRUBE, 1865. Jahresb. d. Schles. Ges. f. Vaterl. Cult., p. 61.

*M. C. Z.

(TEMNOPLEURUS.) PLEURECHINUS.

Pleurechinus AGASS. 1841. Mon. Scut.
Pleurechinus AGASS. 1841. VAL. An. Genre Ech.
Temnopleurus AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Opechinus DES. 1855. Synop. Éch. foss.

Pleurechinus bothryoides

Pleurechinus *bothryoides*! AGASS. 1841. Mon. Scut.
Pleurechinus bothryoides! AGASS. 1841. VAL. Anat. Gen Ech., p. VIII. (non *Cid.* **both.** KLEIN).
Temnopleurus bothryoides! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 360. (pars.)

? Galapagos! (École. Min.).

PODOCIDARIS.

Podocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Podocidaris sculpta

Podocidaris sculpta! A. AGASS. 1869. B. M. C. Z., I. p. 258. Straits of Florida.

*Doublehead Shot Key, Fla., 315 fms., *Florida Gulf Stream, 120, 138, 154 fms. (Pourtalès).

POROCIDARIS.

Porocidaris DES. 1854. Syn. Échin. foss.

Porocidaris purpurata

Porocidaris **purpurata**! W. THOMS. 1869. Prel. Rep. Porcup. Exp. P. R. S.

*Deep water between Rona and Rockall (Porcup. Exp.).

POURTALESIA.

Pourtalesia A. AGASS. 1869. Bull. M. C. Z., I.

Pourtalesia miranda

Pourtalesia miranda! A. AGASS. 1869. Bull. M. C. Z., I. p. 272. Straits of Florida.

*Florida Gulf Stream, 349 fms. (Pourtalès); off Rockall, 1215 fms., Shetland Channel! (Porcupine Exped.).

(STRONGYLOCENTROTUS.) Pseudoboletia.

Boletia A. Agass. 1863. Bull. M. C. Z., I. (pars.)
Pseudoboletia Trosch. 1869. Verhdl. d. Nat. Ver Rheinl. u. West.

Pseudoboletia granulata

Boletia **granulata** ! A. Agass. 1863. Bull. M. C. Z., I. p. 24. Sandwich Islands.
Pseudoboletia stenostoma ! Trosch. 1869. Verhandl. Nat. Ver. Rheinl. u. West., p. 96.

*Sandwich Islands (Garrett).

Pseudoboletia indiana

Toxopneustes **indianus** ! Mich. 1862. Maill. Bourbon, Ann. A., p. 5. Bourbon.
Sphaeriechinus *indianus* Lütk. 1864. Bid.
Pseudoboletia maculata ! Trosch. 1869. Verhandl. Nat. Ver. Rheinl. u. West., p. 96.

*M. C. Z.; Masbate! Philippine Islands! Mauritius! (Brit. Mus.); *Isle de France; Bombay! (École. Min.); Bourbon! (Loriol).

(CASSIDULUS.) Rhynchopygus.

Echinobrissus Breyn. 1732. Schedias. (pars.)
Cassidulus Lamk. 1801. An. s. Vert.
Nucleolites Desml. 1837. Syn. (pars.)
Pygorhynchus Agass. 1860. Proc. Bost. Soc. N. H.
Rhynchopygus Lütk. 1864. Bid.
Rhyncholampas A. Agass. 1869. Bull. M. C. Z., I.

Rhynchopygus caribaearum

Cassidulus caribaearum ! Lamk. 1801. An. s. Vert., p. 349. W. Indies.
Cassidulus caribaearum ! Gray, 1855. Cat. Rec. Echin., p. 34.
" " ! Lütk. 1864. Bid., p. 126, *Pl. II. f. 6.*
Rhynchopygus " ! Lütk. 1864. Bid. Append., p. 1. St. Thomas.
Rhyncholampas *caribaearum* ! A. Agass. 1869. Bull. M. C. Z., I. p. 270.
Cassidulus **australis** ! Lamk. 1816. An. s. Vert., p. 35. (pars.)
" *australis* ! Blainv. 1834. Actin., p. 210.
" " ! Agass. 1847. C. R. Ann. Sc. Nat., VII. p. 157.
" " ! Duj. Hupé, 1862. Échin., p. 582.
" " ! Perrier, 1869. Pédic., p. 170.
" **Richardii** DesLong. 1824. Enc. Méth., *Pl. CXLIII. f. 8, 9, 10.*
Nucleolites Richardii Desml. 1837. Syn., p. 354. (pars.)
" " ! Duch. 1850. Rad. d. Antilles.
Cassidulus **guadeloupensis** ! Duch. 1847. Bull. Soc. Géol. Fr. Guadeloupe.
Rhynchopygus guadeloupensis Des. 1857. Syn. Éch. foss., p. 288.

*St. Thomas (Riise); Jamaica! (Mus. Copenh.); Guadeloupe! (Duchassaing, J. d. P.).

Rhynchopygus pacificus

Pygorhynchus **sp.** ! Agass. 1860. Proc. Boston Soc. N. H., p. 262. Acapulco
" **pacificus** ! A. Agass. 1863. Bull. M. C. Z., I. p. 27.
" *pacificus* ! Verrill, 1867. Notes Radiata, p. 315. Cape St. Lucas.
" " ! Perrier, 1869. Pédic., p. 170.
Rhyncholampas *pacificus* ! A. Agass. 1869. Bull. M. C. Z., I. p. 270.

*Acapulco (A. Agass., Van Brunt); *Panama (Jewett); Cape St. Lucas! (Xanthus, Smithson. Coll.); Galapagos! (Mus. Stockholm).

(HEMIASTER.) RHYNOBRISSUS.

Rhynobrissus A. AGASS. 1872. Bull. M. C. Z., III

Rhynobrissus pyramidalis

Rhynobrissus pyramidalis A. AGASS. 1872. Bull. M. C. Z., III. China Seas.

*Sea of Linguin, China Seas (Liverpool Mus.).

ROTULA.

Echinodiscus BREYN. 1732. Schedias. (pars.)
Rotula KLEIN, 1734. Nat. Disp. Echin.
Placenta BRISSON, 1754. KL. Ed. Gall.
Scutella LAMK. 1816. An. s. Vert. (pars.)
Echinodiscus GRAY, 1825. Ann. Phil. (pars.)
Heliophora AGASS. 1840. Cat. Syst. Ectyp.
Rotula AGASS. 1841. Mon. Scut.
Echinodiscus D'ORBIG. 1854. Rev. Mag. Zool.
" DES. 1857. Synops. Éch.

Rotula Augusti

Echinodiscus ...... BREYN. 1732. *Pl VII. f. 5, 6.*
...... GUALTERI, 1742. *Pl. CX. f. H.*
Echinus alterplanus ...... SEBA, 1758. Thes., III. *Pl. XV. f. 17, 18.*
Rotula Augusti! KLEIN, 1734. Nat. Disp. Ech., *Pl. XXII. f. C, D*, copied, Enc. M., *Pl. CL. f. 5, 6.*
Rotula Augusti! AGASS. 1841. Mon. Scut., p. 28, *Pl. II. f. 1–10; Pl. IV a. f. 1–6.* W. coast Africa.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 17.
" " DESOR, 1857. Synop. Éch. foss.
" " ! DUJ. HUPÉ, 1862. Éch., p. 570.
" " BRONN, 1859. KL. u. Ord. Actin., *Pl. XLI. f. 14.*
Echinodiscus **deciesdigitatus** LESKE, 1778. KL. Add., p. 145, *Pl. XXII. f. A, B.*
" **octiesdigitatus** ! LESKE, 1778. KL. Add., p. 147, *Pl. XXII. f. C, D*, copied in Enc. M., *Pl. CL. f. 3, 4.*
Echinus **octodactylus** GMEL. 1788. LINN. Syst. Nat, 3191.
Scutella octodactyla! BLAINV. 1825. D. S. N. Scut., p. 227.
" " ! AGASS. 1836. Prod., p. 188.
" " ! BLAINV. 1834. Actin, p. 220.
" " DESML. 1837. Syn., p. 222.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XV. f. 2.*
Echinodiscus octodactylus! GRAY, 1825. Ann. Phil., p. 6.
Placenta **rotula** BRISSON, 1754. KLEIN, Ed. Gall., p. 94, *Pl. XII. f. A, B.* (pars)
Scutella digitata! LAMK. 1816. An. s. Vert., p. 8.
Scutella digitata ! AGASS. 1836. Prod., p. 188.
Echinodiscus digitatus! GRAY, 1825. Ann. Phil., p. 6.
Scutella **decadactyla**! BLAINV. 1827. D. S. N. Scut., p. 227.
" *decadactyla*! BLAINV. 1834. Actin., p. 220.
" " DESML. 1837. Syn., p. 222.
Rotula **Gualteri** GRAY, 1855. Cat. Rec. Ech., p. 18.

*Liberia; *Cape Palmas; *W. coast Africa.

Rotula Rumphii

...... RUMPH. 1705. *Pl. XIV. f. 1.*
Echinus planus ...... SEBA, 1758. Thes., III. *Pl. XV. f. 15, 16, 19, 20*, copied, ENC. M., *Pl. CLI. f. 3, 4.*
Echinodiscus dimidia ...... BREYN. 1732. Sched., p. 64, *Pl. VI. f. 3, 4.*
Rotula Rumphii ! KLEIN, 1734. Nat Disp. Ech., *Pl. XXII. f. E, F*, copied in ENC. M., *Pl. CLI. f. 1, 2.*
Rotula Rumphii ! AGASS. 1841. Mon. Scut., p. 25.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 17.
Echinodiscus Rumphii ! DES. 1857. Syn. Éch. foss., p. 238 (non BLAINV.).
" " ! DUJ. HUPÉ, 1862. Échin., p. 570.
Placenta **rotula** BRISSON, 1754. KLEIN, Ed. Gall., p. 196. (pars)
Echinodiscus **dentatus** LESKE, 1778. KLEIN, Add., § 96, *Pl. XXII. f. E, F; Pl. XLIX.* copied from SEBA.
" *dentatus* ! GRAY, 1825. Ann. Phil., p. 6.
Scutella *dentata* ! LAMK. 1816. An. s. Vert., p. 8.
Scutella " ! BLAINV. 1827. D. S. N. Scut., p. 226.
" " ! BLAINV. 1834. Actin., p. 220.
" " ! AGASS. 1836. Prod., p. 188.
" " DESML. 1837. Syn., p. 220.
? *Echinus* **orbiculus** GMEL. 1788. LINN. Syst. N., 3192 (an Mell. testudinata ?)
Scutella **semisol** BLAINV. 1827. D. S. N. Scut, p. 227.
" *semisol* DESML. 1837. Syn., p. 220.
" **radiata** BLAINV. 1834. Actin., p. 220.
" *radiata* AGASS. 1836. Prod., p. 188.
Rotula **digitata** ! AGASS. 1841. Mon. Scut., *Pl. I.* Senegal.
" *digitata* ! AGASS. 1847. C. R. Ann. Sc. Nat., VII. p. 138. (pars.)
Echinodiscus digitatus ! DES. 1857. Syn. Éch. foss., p. 238.
Rotula **Kleinii** ! MICH. MS. (Écol. Min.)

*Senegal; *Cape Verde Islands (Bouvier); Loando! (Écol. Min.); Porto Praya, 20 fms.! (W. Stimpson, Smithson. Coll.).

SALENIA.

Salenia GRAY, 1835. Proc. Z. S. London.
Cidarella DESML. 1837. MS. Et. Echin., p. 207.
Salenocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Salenia varispina

Salenocidaris varispina ! A. AGASS. 1869. Bull. M. C. Z., I. p. 254. Straits of Florida.

*Off Doublehead Shot Key, 135 fms. (Pourtalès).

SALMACIS.

Salmacis AGASS. 1841. VAL. An. Genre Ech.
Salmacis AGASS. 1846. C. R. Ann. Sc. Nat., VI.
Melobosis GIR. 1850. Proc. Bost. Soc. N. H.
Toreumatica GRAY, 1855. Proc. Zoöl. Soc. London. (pars.)
Melebosis (err. typ.) DUJ. HUPÉ, 1862. Échin.
Diploporus TROSCH. MS. 1866. MART. Wieg. Arch.

Salmacis bicolor

Salmacis bicolor ! AGASS. 1841. VAL. Anat. Genre Ech., p. 8.
Salmacis bicolor ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359, *Pl. XV. f. 4*. Bombay. Red Sea.
" " ! DES. 1855. Synops. Ech. foss., p. 109, *Pl. XVII. f. 12*.
" " BRONN, 1859. Kl. u. Ord. Actin., *Pl. XLII. f. 8*.
" " ! DUJ. HUPÉ, 1862. Échin., p. 515.
" " ! PERRIER, 1869. Pédic., p. 139.

*Red Sea; *Zanzibar (Webb, Ropes); *Mauritius (Pike); Bombay! (Mus. Paris); Mozambique! (Mus. Berl.).

Salmacis Dussumieri

Salmacis **Dussumieri** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359. Singapore. China Seas.
Toreumatica concava ! GRAY, 1855. Proc. Zool. Soc. London, p. 39 (non A. AGASS.). Hong Kong.
Salmacis **Desmoulinsii** ! DUJ. HUPÉ, 1862. Échin., p. 516.
Temnopleurus **elegans** ! MICH. MS. Écol. Min.

*M. C. Z; Singapore! China Seas! (J. d. P., Écol. Min.); Philippine Islands! (Semper); Hong Kong (Brit. Mus.).

Salmacis globator

Salmacis **globator** ! AGASS. 1846. C. R. An. Sc. Nat., VI. p. 359.
" *globator* ! DUJ. HUPÉ, 1862. Échin., p. 516.

*Australia; E. and W. coast Australia! (Brit. Mus.).

Salmacis rarispina

Salmacis **rarispinus** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359. Malacca. Singapore.
" *rarispinus* ! DUJ. HUPÉ, 1862. Échin., p. 516.
Melobosis " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 24.
Salmacis **varius** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359. Singapore.
" *varius* ! DUJ. HUPÉ, 1862. Échin., p. 516.
" **pyramidata** ! TROSCH. 1866, in MART. Wieg. Archiv, I. p. 159. (pars.) Timor.
" **festivus** ! GRUBE, 1867. Schles. Ges. f. Vat. Cult. Siam.
" **rubrotinctus** ! GRUBE, 1867. Schles. Ges. f. Vat. Cult.
Melobosis **intermedius** ! GIR. MS. M. C. Z.

*Philippine Islands (Cotteau); Timor! (Martens); Shanghae! (Amherst Coll.); Malacca! Singapore! (J. d. P.); Philippine Islands! (Semper Coll.); Tranquebar! (Mus. Copenh.); Bondy Head! (Brit. Mus.); *Siam (Salmin); Cape York! Banca Straits! (Salmin).

Salmacis sulcata

Salmacis **sulcatus** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359. E. India.
" *sulcatus* ! DUJ. HUPÉ, 1862. Échin., p. 516.
" **virgulatus** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 359. Ceylon.
" *virgulatus* ! DUJ. HUPÉ, 1862. Échin., p. 516.
Melobosis mirabilis ! GIR. 1850. Proc. Boston S. N. H., III. p. 365.
Melebosis *mirabilis* ! DUJ. HUPÉ 1862. Échin., p. 516.
Salmacis **conica** ! MART. 1866. Wieg. Arch., p. 159.
Diploporus pyramidata ! TROSCH. 1866, in MART. Wieg. Arch., p. 159. (pars.)

*Port Mackay (Mus. Godeff.); *New Holland (Cotteau); *East India; Philippine Islands! (Semper); China! (Stockholm Mus.); Ceylon! (J. d. P.); Banca Straits! (Salmin); Red Sea! (Mus. Copenh.); Mozambique! (Peters).

SCHIZASTER.

Echinus LINN. 1758. Syst. Nat. (pars.)
Spatangus LAMK. 1816. An. s. Vert. (pars.)
Ova GRAY, 1825. Ann. Phil.
Micraster AGASS. 1836. Prod.
Brissus DÜB. o. KOR. 1844. Skand. Echin.
Schizaster AGASS. 1847. C. R. Ann. Sc. Nat., VIII.
Tripylus GRAY, 1851. Ann. Mag.
Nina GRAY, 1855. Cat. Rec. Echin.
Brisaster GRAY, 1855. Cat. Rec. Ech.
Tripylus SARS, 1861. Norges Echin.
Periaster DUJ. HUPÉ, 1862. Échin. (pars.)
Paraster POMEL, 1869. Rev. d. Échin.

Schizaster canaliferus

Echinus **lacunosus** LINN. 1758. Syst. Nat., 665. (pars.)
" *lacunosus* GMEL. 1788. LINN. Syst., 3196. (pars.)
Spatangus " LESKE, 1778. Kl. Add
" **canaliferus** ! LAMK. 1816. An. s. Vert., p. 31.
" *canaliferus* ! BLAINV. 1825. Dict. Sc. N. O , p. 90.
" " ! BLAINV. 1834. Actin., p. 202.
" " DESML. 1837. Syn., p. 386.
" " ENC. MÉTH., *Pl. CLVI. f. 1–3.*
Ova " ! GRAY, 1825. Ann. Phil., p. 9.
Micraster " ! AGASS. 1836. Prod., p. 17.
Micraster " PHIL. 1845. Wieg. Arch., I. p. 341.
Schizaster " ! AGASS. 1847. C. R. Ann. Sc. N., VIII. p. 20, *Pl. XVI. f. 6.* Mediterranean.
" " MÜLL. 1852. Abhdl., IV. *Pl. VIII. f. 10–13 ; Pl. VIII. f. 7–10.* (Pluteus.)
" " MÜLL. 1853. Abhdl., VI. *Pl. VII. f. 7–9.*
" " MÜLL. 1854. Bau d. Echin., *Pl. I. f. 6.*
" " MÜLL. 1855. Abhdl , VII. *Pl. V. f. 5, 6 ; Pl. VII.; Pl. VI.* ? (Pluteus.)
" " SARS, 1857. Middelh. Litt. Fauna, p. 117.
" " ! DES. 1858. Syn. Éch. foss., *Pl. XLIII. f. 1, 2.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 603.
" " ! PERRIER, 1869. Pédic., p. 177.
Nina " ! GRAY, 1855. Cat. Rec. Ech., p. 60.
Schizaster cordatus BRONN, 1859. Kl. u. Ord. Actin., p. 341, *Pl. XXXIX. f. 26* (non AUCT.).

*W. coast Italy (Rigacci) ; *Naples (Panceri) ; Triest (Sars) ; Nice (Risso) ; Venice, Lussin (Grube) ; Zara, Lessina (Heller).

Schizaster fragilis

Brissus **fragilis** ! DÜB. o. KOR. 1844. Skand Echin., p. 280, *Pl. X. f. 47, 49.* W. coast Norway.
Schizaster fragilis ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 22.
" " ! LÜTK. 1864. Bid., p. 175.
Brisaster " ! GRAY, 1855. Cat. Rec. Ech., p. 61.
Tripylus " SARS, 1861. Norges Echin., p. 96.
Periaster " ! DUJ. HUPÉ, 1862. Échin , p. 598. Straits of Florida.
Schizaster cubensis ! A. AGASS. 1869. Bull. M. C. Z., I. p. 278 (non D'ORBIG.).

*Lofoten Islands, 100–150 fms. (G. O. Sars) ; *W. coast Norway (Thomson) ; Drontheim — Cape North (McAndrew & Barrett) ; Bergen, Finmark (Sars) ; Gulf of St. Lawrence (Whiteaves, 250 fms.) ; *Straits of Florida (Pourtalès).

Schizaster gibberulus

...... AUDOUIN in SAVIGNY, Égypte Zooph., *Pl. VII. f. 5.*
Schizaster **gibberulus** ! AGASS. 1847. C. R. Ann. Mag. N. H., VIII. p. 22. Red Sea.
Periaster *gibberulus* D'ORBIG. 1854. Pal. fr., p. 270.
Periaster " ! DUJ. HUPÉ, 1862. Échin., p. 598.
" " ! PERRIER, 1869. Pédic., p. 177.
Brisaster " ! GRAY, 1855. Cat. Rec. Echin., p. 61.
Paraster " POMEL, 1869. Rev. d. Échin.

*Red Sea.

Schizaster Philippii

Tripylus **Philippii** GRAY, 1851. Ann. Mag. N. H., VII. p. 132.
" *Philippii* GRAY, 1855. Cat. Rec. Echin., p. 59, *Pl. V. f. 1.* So. Am. Straits Magellan.
Brissopsis " DUJ. HUPÉ, 1862. Échin., p. 597.

*M. C. Z.; Statten Land! (Brit. Mus.).

Schizaster ventricosus

Schizaster **ventricosus** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 133. Australia.
Nina *ventricosus* ! GRAY, 1855. Cat. Rec. Echin., p. 60, *Pl. IV. f. 2.*
Schizaster **Jukesii** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 133. Cape York.
Nina *Jukesii* ! GRAY, 1855. Cat. Rec. Echin., p. 61, *Pl. III. f. 4.*

*Feejee Islands (Godeff. Mus.); Siam! (Bonn Mus.); Hong Kong! (Vienna, Breslau Mus.); Pelew Islands! (Mus. Godeff.); Philippine Islands! (Semper).

SPATANGUS.

Spatangus KLEIN, 1734. Nat. Disp. Ech.
Spatagus MÜLL. 1776. Prod. Zool. Dan. (pars.)
Spatangus LESKE, 1778. KL. Addit. (pars.)

Spatangus Lütkeni

Spatangus **Lütkeni** ! A. AGASS. 1872. Bull. M. C. Z., III. Cape China.
" *altus* LUTK. MS.

*Japan (Salmin, Kölliker); Hakodadi! (W. Stimpson, Smithson. Coll.).

Spatangus purpureus

Echinus Spatangus et Brissus RONDEL. 1554. Lib de piscib. mar., p. 578.
Spatagus purpureus !? MÜLL. 1776. Prod., 2850; Zool. Dan., *Pl. VI.*
Spatangus purpureus LESKE, 1778. KL. Add., p. 170, *Pl. XLIII. f. 3–5*; *Pl. XLV. f. 5*, copied in ENC. MÉTH., *Pl. CLVII. f. 1–3.*
" " ! LAMK. 1816. An. s. Vert., p. 29. Atlantic European.
" " ! GRAY, 1825. Ann. Phil., p. 8.
" " FLEM. 1828. Brit. An., p. 489.
" " ! BLAINV. 1834. Actin., p. 202, *Pl. XIV.*
" " ! AGASS. 1836. Prod., p. 17.
" " DESML. 1837. Syn., p. 388.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XI^{bis}. f. 1*; *Pl. XVII. f. 2.*
" " !? FORBES, 1841. Brit. Starf., p. 182, *f.*
" " DÜB. o. KOREN, 1844. Skand. Ech., p. 285. W. coast Norway.
" " PHIL. 1845. Wieg. Archiv, I. p. 350.
" " ! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 6.
" " ! GRAY, 1848. Brit. Rad., p. 6.
" " ! GRAY, 1855. Cat. Rec. Ech., p. 47.
" " DESOR, 1858. Synops. Éch. foss., *Pl. XLIV. f. 1.*
" " BRONN, 1859. KL. u. Ord. Actin., p. 340, *Pl. XL. f. 21–23.*

Spatangus purpureus (*continued*).
Spatangus purpureus ! SARS, 1861. Norges Ech., p. 99.
" " ! DUJ. HUPÉ, 1862. Échin., p. 607.
" " ! PERRIER, 1869. Pédic., p. 178, *Pl. VII. f. a, d, e.*
Echinus " GMEL. 1788. LINN. Syst. Nat.
" " PENN. 1812. Brit. Zoöl., 2d Ed., *Pl XXXVII.; Pl. XXXV.* 1st Ed.
Spatangus **meridionalis** RISSO, 1826. Europ. Mérid., V. p. 280 (non AUCT. ANGL.).
" *meridionalis* ! BLAINV. 1834. Actin., p. 202.
" " PHIL. 1845. Wieg. Archiv, I., p. 350
" " ! AGASS. 1847. C. R. Ann. Sc. N., VIII. p. 6. Mediterranean. Algeria.
" " ! GRAY, 1855. Cat Rec. Echin., p. 47.
" " SARS, 1857. Middelh. Litt. faun., p. 1. Naples.
" " ! DUJ. HUPÉ, 1862. Échin., p. 608.
" " ! PERRIER, 1869. Pédic., p 190.
" **spinosissimus** ! AGASS. 1847. C. R. Ann. Sc. N., VIII. p. 6. European Seas.
" *spinossissimus* ! GRAY, 1855. Cat. Rec. Echin., p. 47.
" **Reginae** ! GRAY, 1851. Ann. Mag. N. H., VII. p. 130. Malta.
" *Reginae* ! GRAY, 1855. Cat. Rec. Echin., p. 47, *Pl. III. f. 1.*

*German Ocean; Oresund; *Dröback (Eschricht); *Lofoten Islands, 20–40 fms. (G. O. Sars); Rochelle! Cherbourg! W. coast France! (J. d. P.); N. & E. Ireland (Thomson); Irish Sea! (Liverpool Mus.); Shetland Islands (Norman); Drontheim — N. Cape (McAndrew & Barrett); *British Seas; Heligoland, Finmark (Sars); Isle of Man, Weymouth (Forbes); Katwijck (Maitland); *Cape Sagras (Porcup. Exped.); *Mediterranean; Naples, Messina (Sars); Malta (Brit. Mus.); Nice (Risso); Zara, Lessina (Heller); Lussin (Grube); *W. coast Italy (Rigacci).

Spatangus Raschi
Spatangus **Raschi** ! LOVÉN, 1869. Öfv. Skand. Vet. Akad. Forh. German Ocean.
" *meridionalis* (AUCT. ANGLIC.) **Norman** 4th Dredging Rep. Brit. Ass., 1868.

*W. Ireland (Porcupine Exped.); Azores! (Breslau Mus.); Storeggen Bk., 200 fms. (Rasch); Shetland Islands (Barrett, Norman); off Valencia! 110 fms. (Porcupine Exped.).

(STRONGYLOCENTROTUS.) SPHAERECHINUS.

Echinus LAMK. 1816. An. s. Vert. (pars.)
Toxopneustes AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.) (non AGASS. 1841.)
Sphaerechinus DES. 1857. Synop. Éch. foss.
Sphaeriechinus LÜTK. 1864. Bid. (err. typ.)

Sphaerechinus Australiae
Sphaerechinus **Australiae** ! A. AGASS. 1872. Bull. M. C. Z., III.
Cryptopora " ! MICH. MS. (Écol. Min.). Australia.
Pachechinus " ! A. AGASS. MS. M. C. Z.

*Australia (B. M. Wright); Mauritius! (Écol. Min.); New Zealand! Tasmania! E. coast Australia! Adelaide! (Brit. Mus.)

Sphaerechinus granularis
Echinus **ovarius** RONDEL. 1554. Lib. de piscib. marin., p. 578.
" **granularis** ! LAMK. 1816. An. s. Vert., p. 44.
Toxopneustes granularis ! AGASS. 1846. C. R. Ann. Sc. Nat., p. 367.
" " ! DUJ. HUPÉ, 1862 Échin., p. 531.
Sphaerechinus " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 23. Fayal.
Sphaeriechinus *granularis* LÜTK. 1864. Bid., p. 148.

Sphaerechinus granularis (*continued*).

Echinus **brevispinosus** RISSO, 1826. Europ. Mérid., V. p. 277. Mediterranean.
" *brevispinosus*! VAL. 1841. Anat. Ech., *Pl. I. f. 4–6, 9; Pls. II., VII.* (pars.)
" " MÜLL. 1852. Abhdl., V. *Pl. VIII. f. 1–9;* VI. *Pl. VIII. f. 3–6;* VII. *Pl. I.* (Pluteus.)
" " MÜLL. 1854. Bau d. Echin., *Pl. II. f. 5.*
Toxopneustes brevispinosus! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 36. N. shore Africa.
" " SARS, 1857. Middelh. Litt. faun, p. 112. Naples.
" " ! DUJ. HUPÉ, 1862. Échin., p. 531.
Sphaerechinus " ! DESOR, 1857. Synops. Éch. foss., p. 134.
Echinus esculentus! BLAINV. 1825. Dict. Sc. N. O, p. 86 (non LINN.).
" " ! BLAINV. 1834. Actin., *Pl. XIX.*
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XI. f 1.*
Sphaerechinus esculentus BRONN, 1859. KL. u. Ord. Actin., p. 337, *Pl. XXXVII. f. 1–3, 5–14, 16–19: Pl. XXXIX. f. 6.*
Echinus **equituberculatus**! BLAINV. 1825. Dict. Sc. N. O., p. 86 (non p. 76).
" *equituberculatus*! BLAINV. 1834. Actin., p. 228 (non p. 226).
" **aequituberculatus** DESML. 1837. Syn., p. 280.
Toxopneustes " ! DUJ. HUPÉ, 1862. Échin., p. 531.
Echinus **subglobiformis**! BLAINV. 1825. Dict. Sc. N. O., p. 89.
" *subglobiformis* DESML. 1837 Syn., p. 282.
" **dubius**! BLAINV. 1825. Dict. Sc N. O., p. 87.
" *dubius*! BLAINV. 1834. Actin., p. 228.
" " DESML. 1837. Syn., p. 280.
Toxopneustes **albidus**! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 367. W. coast France. (pars.).
" *albidus*! DUJ. HUPÉ, 1862. Échin., p. 531.

*Mediterranean; *Madeira (W. Stimpson, Smithson Coll.); *Nice (Verany); *Naples (Panceri); *W. coast Italy! (Rigacci); *Fayal (Higginson, Dabney); *Sicily; N. coast Africa! Cape Verde Islands! W. coast France! (J. d. P.); Genoa (Verany); Messina (Sars); Spain, Portugal, W. Africa, Canary Islands (Forbes); Venice, Lussin (Grube); Lissa, Lessina, Ragusa, E. coast Adriat. (Heller).

Sphaerechinus pulcherrimus

Psammechinus **pulcherrimus**! BARN. 1863, in A. AG. Proc. Acad. N. S. Phila., p. 357. Hakodadi.
Holopneustes **complanatus** HERKL. MS. Leyd. Mus. (teste MARTENS).
Discaster Bernardi MICH. MS. École Min. (Monstrosity.)

*Hakodadi (W. Stimpson, Smithson. Coll.); Nagasaki! (Martens); Japan! China Seas! (École Min.).

STEPHANOCIDARIS.

Cidarites LAMK. 1816. An. s. Vert. (pars.)
Cidaris AGASS. 1836. Prod. (pars.)
Stephanocidaris A. AGASS. 1863. Bull. M. C. Z., I.

Stephanocidaris bispinosa

Cidarites **bispinosa**! LAMK. 1816. An. s. Vert., p. 57. New Holland.
" *bispinosa* DESML. 1837. Syn., p. 326.
Cidaris " ! AGASS. 1836. Prod., p. 21.
Stephanocidaris *tubaria*! A. AGASS. 1863. Bull. M. C. Z., I. p. 18 (non C. tubaria LAMK.).

*Australia, Malacca! (J. d. P.); Australia! (Peron et Les.).

STOMOPNEUSTES.

Echinus LAMK. 1816. A. s. Vert. (pars.)
Stomopneustes AGASS. 1841. Monog. Scut. Int.
Heliocidaris DESML. 1846. AGASS. C. R. Ann. Sc. Nat., VI. (pars.)

Stomopneustes variolaris

...... SEBA, 1758. Thes., III. *Pl. XIII. f. 5, 6.*
Echinus **variolaris** ! LAMK. 1816. An. s. Vert., p. 47. So. Pacific.
" *variolaris* ! BLAINV. 1825. Dict. Sc. Nat. O., p. 90.
" " DESLONG. E. M., *Pl. CXXXV.*
" " BLAINV. 1834. Actin., p. 228.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 284.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 10. Isle de France.
Stomopneustes *variolaris* ! AGASS. 1841. Monog. Scut. Int.
Stomopneustes " AGASS. 1841. VAL. Anat. G. Echin., p. X.
Heliocidaris " DESML. 1847. AGASS. C. R. Ann. Sc. Nat., VI. p. 371.
Heliocidaris " ! DUJ. HUPÉ, 1862. Échin., p. 537.
" " ! PERRIER, 1869. Pédic., p. 158.
Echinus **paucituberculatus** ! BLAINV. 1825. Dict. S. N. O., p. 80.
" *paucituberculatus* ! BLAINV. 1834. Actin., p. 227.
" " DESML. 1837. Syn., p. 274.
Heliocidaris *paucituberculata* ! DESML. 1847. AGASS. C. R. Ann. Sc. Nat., VI. p. 371.
Heliocidaris " ! DUJ. HUPÉ, 1862. Échin., p. 537
Echinus **anguifer** DESML. 1837. Syn., p. 276.
" **Leschenaulti** ! BLAINV. 1825. D. S. Nat. O., p. 93.
Echinometra Leschenaulti ! BLAINV. 1834. Actin., p. 225.
" " DESML. 1837. Syn., p. 260.

*Mauritius (Pike) ; *Zanzibar (Cheney) ; *Samoa (Acad. N. S. Phila.) ; *Mozambique (Cook) ; *Calcutta (Theobald) ; Natal ! (Mus. Stutt.) ; Java ! Reunion ! (Cotteau).

STRONGYLOCENTROTUS.

Echinus LINN. 1758. Syst. Nat.
" MÜLL. 1776. Prod. Zoöl. Dan. (pars.)
" MOL. 1782. Chili.
Strongylocentrotus BRANDT. 1835. Prod. (pars.)
Toxopneustes AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Echinus AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Heliocidaris DESML. 1846. AGASS. C. R. Ann. Sc. Nat., VI. (pars.)
Echinometra GRAY, 1848. Brit. Rad. (pars.)
Loxechinus DES. 1855. Synops. Échin.
Psammechinus DUJ. HUPÉ, 1862. Échin. (pars.)
Sphaerechinus DUJ. HUPÉ, 1862. Échin. (pars.)
Toxocidaris A. AGASS. 1863. Bull. M. C. Z., I.
Anthocidaris LÜTK. 1864. Bid.
Euryechinus VERRILL, 1866. Proc. Bost. Soc. N. H.
Echinometra PERRIER, 1869. Pédic. (pars.)

Strongylocentrotus albus

Echinus **albus** Mol. 1782. Chili, p. 175. Chili.
" *albus*! Agass. 1846. C. R. Ann Sc. Nat., VI., p. 368. Callao.
" " Müll. 1854. Bau d. Echin., *Pl. II. f. 2.*
Loxechinus *albus*! Des. 1855. Syn. Éch. foss., p. 136.
Loxechinus " Bronn, 1859. Kl. u. Ord. Actin., *Pl. XXXIX. f. 9.*
" " ! Duj. Hupé, 1862. Échin., p. 535, *Pl. IX. f. 2.*
Echinus **eurythrogrammus** ! Val. 1846. Voyage Vénus. (pars.)

*Chili, *Mejillones (Putnam); Callao! (J. d. P.); Straits Magellan! (Mus. Stockh.); ? Philippine Islands! (Semper).

Strongylocentrotus armiger

Strongylocentrotus **armiger** A. Agass. 1872. Bull. M. C. Z., III.

*Australia.

Strongylocentrotus depressus

Toxocidaris **depressa** ! A. Agass. 1863. Proc. A. N. S. Phil., p. 356. Niphon.
Echinus **disjunctus** ! Mart. 1866. Wieg. Arch., I. p. 135. Nagasaki.

*N. End Niphon (Stimpson); *Yedo (Dall, Smithson. Coll.); Nagasaki! (Martens).

Strongylocentrotus Dröbachiensis

Echinus **Dröbachiensis** ! ? Müll. 1776. Prod. Zool. Dan., p. 235. German Ocean. Norway.
Toxopneustes Dröbachiensis! Agass. 1846. C. R. Ann. Sc. N., VI. p. 367.
" " ! Lütk. 1857. Gronl. Ech., p. 24. Greenland.
" " ! Sars, 1857. Middelh. Litt. fauna, p. 115.
" " ! Sars, 1861. Norges Echin., p. 95.
" " ! Duj. Hupé, 1862. Échin. p. 532.
" " ! A. Agass. 1863. Proc. Boston S. N. H., p. 191.
" " ! A. Agass. 1863. Mem. Am. Ac., *f. 1 - 28.* (Pluteus and juv.)
" " ! A. Agass. 1863. Bull. M. C. Z., I. p. 23.
" " ! A. Agass. 1863. Proc. A. N. S. Phila., p. 357.
" " ! A. Agass. 1865. Seaside Studies, p. 101, *f. 131 - 138, 173 - 181.* (Pluteus).
" " ! Stewart, 1865. Trans. Lin. Soc. Lond., XXV. *Pl. L. f. 3.*
Echinometra " ! Gray, 1848. Brit. Rad., p. 4.
Euryechinus " ! Verrill, 1866. Proc. Boston S N. H., p. 341, 352.
Echinus saxatilis Fab. 1780. Fauna Groenl., p. 368 (non Müll.).
" **neglectus** ! Lamk. 1816. An. s. Vert., p. 49. Atlantic. Europ.
" *neglectus* ! Agass. 1836. Prod., p. 190.
" " !? Forbes, 1841. Brit. Starf., p. 172, *f.*
" " ! Düb. o. Koren, 1844. Skand. Echin., p. 277.
Toxopneustes neglectus ! Agass. 1846. C. R. Ann. Sc. N., VI. p 367. Iceland.
" " ! Grube, 1851. Midd. Reise, II. p. 34.
" " ! Desor, 1855. Syn. Éch. foss., *Pl. XVII bis. f. 1, 2.*
Echinus subangularis Flem. 1828. Brit. An., p. 479 (non Leske).
Strongylocentrotus chlorocentrotus Brandt, 1835. Prod., p. 264. Sitka.
Echinus chlorocentrotus Br. 1835. Prod.
" " Desml. 1837. Syn., p. 282.
Toxopneustes " ! Lütk. 1864. Bid., p. 144.
Echinus granularis ! Say, 1827. Journ. A. N. S. Phila., p. 225 (non Lamk.). Maine.
" *granulatus* ! Gould, 1841. Rep. Inv. Mass. Mass. Bay.
Toxopneustes " ! Agass. 1846. C R Ann. Sc. N., VI. p. 368.
" " ! Lütk. 1864. Bid., p. VI.
Euryechinus " ! Verrill, 1866. Proc. Boston S. N. H., pp. 340, 352.
Toxopneustes **Dubenii** ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 368. Arctic Seas.
" *Dubenii* ! Duj. Hupé, 1862. Échin., p. 532.

Strongylocentrotus Dröbachiensis (*continued*).

Echinus chloroticus! STIMPS. 1857. Crust. Echin. Pacif. Sh., p. 86.
Toxopneustes **carnosus**! BARN. 1863, in AGASS. Proc. A. N. S. Phila., p. 357. Avatcha Bay.
" **pictus**! NORM. 1870. Dredg. Rep. Heb., p. 314. Shetland.
" **pallidus**! SARS, 1870. Nye Echin. Vid. Selsk. Christiania.

*Norway (Sars); *Oresund (Eschricht); *Lofoten Islands, l. w., 60 fms. (G. O. Sars); *Great Britain (W. Stimpson); *Kattegat; *Greenland (Mus. Copenh.); *Labrador (Wyman); *Newfoundland (Dix); *Halifax (Hill); *Grand Menan (Mills); *Trenton Point, Me. (Verrill, Shaler, Hyatt); *Eastport (Stimpson); *Mass. Bay, *Nantucket, *S. Shoals (Agassiz); Cape Cod (A. Agassiz); *Charleston, S. C.? *Cape Florida? (Würdemann); *New Jersey coast (Gedney, Smithson. Coll.); *Hudson Bay (Drexler, Smithson. Coll.); *Gulf Georgia, W. T. (A. Agassiz); Sitka (Martens); *Avatcha Bay, *Behring Strait, Gulf of Penshinsk, Okhotch Sea (Stimpson, Smithson. Coll.); De Castries Bay! (Mus. Godeff.); Siberia (Middendorf); *Spitzbergen, Finmark! Iceland! Vancouver! (Mus. Stock.); Straits Belle Isle! Anticosti! Mingan Islands! (Packard); Gaspé (Dawson); Point Judith (Leidy); Long Island Sound (Verrill); Shetland, Orkney Islands (Forbes); Cape North (McAndrew & Barrett).

Strongylocentrotus eurythrogrammus

Echinus **eurythrogrammus**! VAL. 1846. Voyage Vénus, Zooph., *Pl. VII. f. 1.*
Heliocidaris eurythrogramma! DES. 1846. C. R. Ann. Sc. N., VI. p. 371.
" " ! DUJ. HUPÉ, 1862. Échin., p. 537.
Anthocidaris " ! LÜTK. 1864. Bid., p. 165.
Toxocidaris " VERRILL, 1871. Trans. Conn. Acad., I.
Echinus **tuberculatus**! LAMK. 1816. A. s. Vert., p. 50. (Juv. pars.) So. Pacific.
" *tuberculatus*! BLAINV. 1825. Dict. Sc. N. O, p. 90.
" " ! BLAINV. 1834. Actin., p. 228.
" " DESML. 1837. Syn., p. 284.
Toxopneustes *tuberculatus*! AGASS. 1841. An Genre Ech. VAL., p. IX. (pars.)
Toxopneustes " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 367. (pars.)
" " ! DUJ. HUPÉ, 1862. Échin., p. 532.
Echinus **Delalandi**! VAL. 1846. AGASS. C. R. Ann. Sc. N., VI, p. 367. New Holland.
Toxopneustes Delalandi! AGASS. 1846. C. R. Ann. Sc. N., VI. p. 367.
" " DUJ. HUPÉ, 1862. Échin, p. 532.
Toxocidaris " ! A. AGASS. 1863. Bull. M. C. Z., I. p. 22.
Toxocidaris " ! A. AGASS. 1863. Proc. A. N. S. Phila, p. 356
Euryechinus " VERRILL, 1866. Proc. Bost. Soc. N. H.

*Port Jackson (Stimpson, Smithson. Coll.); *Hobson's Bay (Edwards); Chili! (J. d. P.) *Samoa Islands (Mus. Godeff.); Bass Straits! Van Diemen's Land! Bondy Head! Sidney! Torres Straits! (Brit. Mus.).

Strongylocentrotus franciscanus

Toxocidaris franciscana! A. AGASS. 1863. Bull. M. C. Z., I. p. 22. San Francisco.
Toxocidaris **globulosa**! A. AGASS. 1863. Proc. A. N. S. Phila., p. 356. Keelung. Hakodadi.

*Keelung, Formosa (Stimpson, Smithson. Coll.); ?Sidney! (Brit. Mus.); *San Francisco (Cary); *San Diego (Jewett); *Mendocino (A. Agassiz); Puget Sound! (Smithson. Coll.); Columbia River! (Brit. Mus.); Hakodadi! (Smithson. Inst.).

Strongylocentrotus Gaimardi

Echinus **Gaimardi**! BLAINV. 1825. Dict. S. N. O., p. 86. Rio.
" *Gaimardi*! BLAINV. 1834. Actin., p. 228.
" " DESML. 1837. Syn, p. 280.
" **aciculatus**! HUPÉ, 1856. CASTELNAU Voyage, Am. Sud. Zooph., p. 97, *Pl. I. f 2.* Brazil.
Psammechinus aciculatus! DUJ. HUPÉ, 1862. Échin., p. 528.

*Desterro (Fitz Müller); Brazil! (J. d. P.); *Brazil (Hartt, Copeland, Thayer Exp); Rio, Bahia (Mus. Copen.).

Strongylocentrotus gibbosus

Echinus **gibbosus** ! VAL. (MS. Mus. Paris).
Toxopneustes gibbosus ! AGASS. 1846. C. R. Ann. Sc. N., VI. p. 367. Galapagos.
Sphaerechinus " ! DUJ. HUPÉ, 1862. Échin., p. 530.
Euryechinus gibbus ! VERRILL, 1866. Proc. Bost. Soc. N. H., p. 341. Peru.
Euryechinus **imbecillis** ! VERRILL, 1867. Notes Radiata, p. 305. Callao.
Echinus **conicus** ! TROSCH. (MS. Mus. Frankfort.)

*Galapagos, *Chili (J. d. P.) ; *Callao, Paita (Bradley, Yale Coll.) ; *Feejee Islands ?

Strongylocentrotus intermedius

Psammechinus **intermedius** ! BARN. 1863, in A. AGASS. Proc. Acad. N. S. Phila., p. 357. Hakodadi.
Boletia **radiata** ! MART. 1866. Wieg. Archiv, I. p. 136. Naryasaki.
Toxopneustes **grandiporus** LÜTK. (MS. Mus. Copenh.). Seghalion.

*Ousima (W. Stimpson, Smithson. Coll.) ; *Seghalion (H. A. Pierce) ; *New Holland.

Strongylocentrotus lividus

...... KLEIN, 1734. Nat. Disp. Ech., *Pl. XXX. f. C, D : Pl. XXXI. f. A, B.*
Echinus saxatilis LINN. 1758. Syst. Nat. p. 664, Ed. X. (non RUMPH. nec MULL.).
" " GMEL. 1788. LINN. Syst., 3171.
" " TIED. 1816. Anat. d. Rohren. Hol, *Pl. X.*
" **lividus** ! LAMK. 1816. An. S. Vert., p. 50. Mediterranean.
" *lividus* ! BLAINV. 1825. Dict. Sc. N., p. 88.
" " ! BLAINV. 1834. Actin., p. 228.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 282.
" " EDW. in CUV. Règ. An. Ed. Ill., *Pl. XI. f. 2 - 4.*
" " !? FORBES, 1841. Brit. Starf., p. 167, *f.*
Strongylocentrotus lividus BRANDT, 1835 Prod.
Echinus " ! VAL. 1841. Anat. Genre Echin., *Pl. I. f. 1 - 3,* et passim, *Pl. II - IX.*
Toxopneustes " ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 367.
" " KROHN, 1849. Echinod. Larv., *Pl.* (Pluteus.)
" " SARS, 1857. Middelh. Litt. fauna, p. 162.
" " ! DUJ. HUPÉ, 1862. Échin., p. 532.
" " MÜLL. 1853. Abhandl. IV., *Pl. VI. f. 7 - 14 : Pl. VII. f. 1 - 8.* (Pluteus.)
" " BRONN, 1859. Kl. u. O. Actin, p. 333, *Pl XXXVII. f. 4 - 15 ; Pl. XXXVIII. ; Pl. XL f. 1 - 19.*
" " METCHNI. 1870. Nem. u. Echinod., *Pl. VII. f. 1 - 7 : Pl. VIII. f. 8, 9.* (Pluteus.)
Euryechinus " ! VERRILL, 1866. Proc. Boston S. N. H., p. 341.
Echinus **vulgaris** ! BLAINV. 1825. Dict. Sc. Nat. O., p. 86.
" *vulgaris* ! BLAINV. 1834. Actin., p. 228.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 278.
" *purpureus* RISSO, 1826. Europ. Mérid., V. p. 277 (non GMEL.).
" " GRAY, 1848. Brit. Rad., p. 4.
Toxopneustes **concavus** ! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 367.
" *concavus* ! DUJ. HUPÉ, 1862. Échin., p. 532.
Echinus **complanatus** ! VAL. (MS. Mus. Paris).
Toxopneustes complanatus ! AGASS. 1846. C. R. Ann. S. Nat., VI. p. 367.
" " ! DUJ. HUPÉ, 1862. Échin., p. 532.
" **mammillatus** ! MICH. (MS. Mus. Écol. Min. Paris).

*Finistère, *Loire (Caillaud) ; *Nice (Verany, Burkhardt) ; *Cette (Lyman) ; *Spezzia ; *W. coast Italy (Rigacci) ; *Fayal (Dabney, Higginson) ; *Lanzerote (Haeckel) ; Triest, Messina (Sars) ; Marseilles (Müller) ; So. England (Forbes).

Strongylocentrotus mexicanus

Toxocidaris *mexicana*! (**A. Agass.**) 1863. Bull. M. C. Z., I. p. 22 (non Hel. mex. AG.). Acapulco.
Toxocidaris mexicana! VERRILL, 1871. Notes Radiata, p. 584.
Toxopneustes sp.! VERRILL, 1867. Notes Radiata, p. 307.

*Cape St. Lucas, Gulf of California! (Xanthus, Smithson. Coll.).

Strongylocentrotus nudus

Toxocidaris **nuda**! A. AGASS. 1863. Proc. A. N. S. Phila., p. 356. Hilo. Niphon.

*Sandwich Islands, N. End Niphon (W. Stimpson).

Strongylocentrotus purpuratus

Echinus **purpuratus**! STIMPS. 1857. Crust. Echin. Pac. Coast, p. 86. San Francisco.
Loxechinus purpuratus! A. AGASS. 1863. Bull. M. C. Z., I. p. 23. Mendocino.
" " ! A. AGASS. 1863. Proc. Acad. N. S. Phila., p. 357.
Echinometra **No. 274**! PERRIER, 1869. Pédic.

*California; *Crescent City, *Mendocino, *San Francisco (A. Agassiz); Puget Sound! (Smithson. Coll.).

Strongylocentrotus tuberculatus

Echinus **tuberculatus**! LAMK. 1816. A. s. Vert., p. 50. (pars.) So. Pacific.
Strongylocentrotus *tuberculatus* BR. 1835 Prod.
Toxopneustes tuberculatus AGASS. 1846. C. R. Ann Sc Nat., VI. p. 367. (pars.)
Echinus **omalostoma**! VAL. 1846. Voyage Vénus, Zooph., *Pl. VI. f. 2.* New Zealand.
Heliocidaris omalostoma! DES. 1846. AGASS. C. R. Ann. Sc. N., VI. p. 372. China.
Heliocidaris " ! DUJ. HUPÉ, 1862 Échin., p. 537.
Anthocidaris *homalostoma*! LÜTK. 1864. Bid., p. 165.
Toxocidaris homalostoma VERRILL, 1871. Proc. Conn. Acad., I.
Toxocidaris **crassispina**! A. AGASS. 1863. Proc. A. N. S. Phila., p. 356. Hong Kong.
" **purpurea**! MART. 1866. Wieg. Arch., p. 137. Nagasaki.

*Hakodadi (W. Stimpson, Dall, Smithson. Coll.); *Kanagawa (Heco); *Yokohama (Salmin); *Hong Kong (Behm, Kiel Mus.); Japan (École. Min.); Nagasaki! (Martens, Mus. Berl.); New Holland! (Mus. Copenh.); New Zealand! China! Galapagos! (J. d. P.).

TEMNECHINUS.

Temnechinus FORBES, 1852. Monog. Echinod, Brit. Tertiaries.
Genocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Temnechinus maculatus

Genocidaris maculata! A. AGASS. 1869. Bull. M. C. Z., I. 262. Straits of Florida.

*Off Tortugas, 30, 34, 35, 37, 60, 68 fms., *off Alligator Reef, 79, 88, 138, 147, fms., *S. W. Sand Key, 10, 119, 125, 138 fms, *off Conch Reef, 9, 30, 39, 49, 77, 169 fms., *Florida Gulf Stream, 16, 75 fms., *off Carysfort Reef, 40, 48, 60, 63 fms., *off Tennessee Reef, 115 fms., *off Elbow Reef, 75 fms., *off French Reef, 147 fms., *Key West, off Sand Beach, 5 fms., (Pourtalès); Josephine Bank! 600 fms. (Mus. Stock.).

TEMNOPLEURUS.

Cidaris Klein, 1734. Nat. Disp. Echin. (pars.)
Echinus Lamk. 1816. An. s. Vert. (pars.)
Temnopleurus Agass. 1841. Mon. Scut. Introd.
Temnopleurus Agass. 1841. Val. Anat. Genre Echin.
Toreumatica Gray, 1855. Proc. Zoöl. Soc. London. (pars.)
Toreumatica A. Agass. 1863. Proc. A. N. S. Phila. (pars.)
Microcyphus A. Agass. 1863. Proc. A. N. S. Phila.
Temnotrema A. Agass. 1863. Proc. A. N. S. Phila.

Temnopleurus Hardwickii

Toreumatica Hardwickii ! Gray, 1855. Proc. Zoöl. Soc. London, p. 39.
Microcyphus **elegans** ! A. Agass. 1863. Proc. Phil. Acad. N. S. p. 357. Yedo.
Temnopleurus **japonicus** ! Mart. 1866. Wieg. Arch., p. 133. Hakodadi. Jesso.
Temnotrema sculpta A. Agass. 1863. Proc. Ac. N. S. Phila., p. 358. Japan.

*E. coast Niphon (Stimpson, Smithson. Coll.); *Japan (Salmin); Hakodadi! (Stimpson, Smithson. Coll.); *Yokohama (Berl. Mus.); Nagasaki! Yedo! (Berlin Mus.); Unalaska! (Dall, Smithson. Coll.); *Kagosima (Stimpson, Smithson. Coll.).

Temnopleurus Reynaudi

Temnopleurus **Reynaudi** ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 360. Ceylon.
" *Reynaudi* ! Duj. Hupé, 1862. Échin., p. 514. China.
Toreumatica Reevesii ! Gray, 1855. Proc. Zoöl. Soc. London, p. 39 (non Temn. Reev. A. Ag.).
Toreumatica granulosa ! Gray, 1855. Proc. Zoöl. Soc. London, p. 39.
Toreumatica concava ! A. Agass. 1863. Proc. A. N. S. Phila, p. 358 (non Gray). Hong Kong.

*Ceylon (Humbert, Loriol); *Hong Kong (Putnam); Isle Negros! China! (Brit. Mus.); Malacca! (J. d. P.); Burmah! (Acad. N. S. Phila.); No. China Seas! (Stimpson, Smithson. Coll.).

Temnopleurus toreumaticus

Cidaris toreumatica ! Klein, 1734. Nat. Disp. Ech., p. 64, *Pl. X. f. E.*
Cidaris toreumatica Leske, 1778. Kl. Add., p. 155, *Pl. X. f. E.*
Echinus toreumaticus Gmel. 1788. Linn. Syst. N., 3180.
" " ! Blainv. 1825. Dict. Sc. Nat. O., p. 82.
" " ! Blainv. 1834. Actin., p. 227.
" " Desml. 1837. Syn., p. 274.
" " ! Val. 1846. Voyage Vénus, Zooph., *Pl. I. f. 1.*
Temnopleurus *toreumaticus* ! Agass. 1841. Mon. Scut.
Temnopleurus " ! Agass. 1841. Val. Anat. Genre Echin., p. VII.
" " ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 360, *Pl. XV. f. 9.* Bombay.
" " Desor, 1856. Synops. Échin. foss., p. 108, *Pl. XVII. f. 8–10.*
" " ! Duj. Hupé, 1862. Échin., p. 514.
" " ! A. Agass. 1863. Bull. M. C. Z., I. p. 23.
Echinus **sculptus** ! Lamk. 1816. An. s. Vert., p. 47. Indian Ocean?
" *sculptus* DesLong. 1824. Enc. Méth., II. p. 590, *Pl. CXLII. f. 4, 5.*
Temnopleurus bothryoides ! Agass. 1846. C. R. Ann. Sc. Nat., VI. p. 360. (pars.)
" *Reevesii* ! A. Agass. 1863. Bull. M. C. Z., I. p. 23 (non Tor. R. Gray). Hong Kong.
" " ! A. Agass. 1863. Proc. An. S. Phila., p. 358.

*Bombay; *E. India (Phila. Acad.); *Philippine Islands (Cotteau); *Hong Kong (Putnam); *Siam (Salmin); No. China Sea! (Stimpson, Smithson. Coll.); Karrak Island, Gulf of Persia! (J. d. P.); China! (Mus. Copenh.).

TOXOPNEUSTES.

Echinus LAMK. 1816. A. s. Vert. (pars.)
Toxopneustes AGASS. 1841. Int. Monog. Scut. (non AGASS. 1841, Anat. Echin.).
Psammechinus AGASS. 1846. C. R. Ann. Sc. Nat., VI. (pars.)
Boletia DES. 1846. C. R. Ann. Sc. Nat., VI. p. 362.
Anapesus HOLMES, 1860. Post Plioc. foss. So. Ca.
Boletia AGASS. 1861. Cont. Nat. H. U. S., I. p. 97.
Lytechinus A. AGASS. 1863. Bull. M. C. Z., I.
Psilechinus LÜTK. 1864. Bid.
Lytechinus VERRILL, 1867. Notes Radiata.
Boletia VERRILL, 1871. (pars.)
Hemiechinus GIRARD, MS.

Toxopneustes maculatus

...... GUALTERI, 1742. *Pl. CVII. f. M.*
...... SEBA, 1758. Thes., III. *Pl. XI. f. 6, 8.*
Echinus **maculatus** ! LAMK. 1816. An. s. Vert., p. 46. Indian Ocean ?
" *maculatus* ! BLAINV. 1825. Dict. S. N. O., p. 87.
" " ! BLAINV. 1834. Actinol., p. 228.
" " DESML. 1837. Syn., p. 280.
Boletia *maculata* ! DES. 1846. C. R. Ann. Sc. Nat., VI. p. 363.
Boletia " ! DUJ. HUPÉ, 1862. Échin., p. 534, *Pl. IX f. 9.*
Echinus **depressus** ! BLAINV. 1825. Dict. S. N. O., p. 84.
" *depressus* ! BLAINV. 1834. Actinol., p. 228.
" " DESML. 1837. Syn., p. 276.
" " ! VAL. 1846. Voyage Vénus, Zooph., *Pl. III. f. 1.*
Hemiechinus *depressus* ! GIR. MS.

*Christmas Island (J. D. Hague) ; Bourbon ! (École. Min.).

Toxopneustes pileolus

Echinus **pileolus** ! LAMK. 1816. An. s. Vert., p. 45. Isle de France.
" *pileolus* ! BLAINV. 1825. Dict. S. N. O., p. 90.
" " ! BLAINV. 1834. Actinol., p. 228.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 284.
" " ! MICH. 1845. Rev. Mag. Zoöl., p. 9.
" " ! VAL. 1846. Voyage Vénus, Zooph., *Pls. VIII., IX.*
Boletia " ! DES. 1846. C. R. Ann. Sc. Nat., VI. p. 362.
Boletia " MÜLL. 1854. Bau d. Echin., *Pl. II. f. 3.*
" " BRONN, 1859. Klassen u. Ord. Actin., *Pl. XXXIX. f. 7.*
" " ! DUJ. HUPÉ, 1862. Échin., p. 534, *Pl. IX. f. 4.*
" " ! PERRIER, 1869. Pédic., p. 157.
Toxopneustes *pileolus* AGASS. 1841. Int. Mon. Scut.
Echinus **polizonalis** ! LAMK. 1816. An. s. Vert., p. 45.
" *polizonalis* ! BLAINV. 1825. Dict. S. N. O., p. 84.
" " ! BLAINV. 1834. Actinol., p. 228.
" " DESML. 1837. Syn., p. 276.
Boletia " ! MART. 1866. Wieg. Arch., I. p. 162. Molucca. Timor.
Echinus **obtusangulus** ! LAMK. 1816. An. s. Vert., p. 46. Indian Ocean.
Boletia heteropora ! DES. 1846. C. R. Ann. Sc. Nat., VI. p. 362. Indian Ocean.
Boletia heteropora ! DUJ. HUPÉ, 1862. Échin., p. 534.

Toxopneustes pileolus (*continued*).

Echinus **trizonalis**! BLAINV. 1825. Dict. S. N. Oursin, p. 84.
" *trizonalis*! BLAINV. 1834. Actinol., p. 228.
" " DESML. 1837. Syn., p. 276.
Boletia bizonata! DES. 1846. C. R. Ann. Sc Nat., VI. p. 363.
Boletia bizonata! DUJ. HUPÉ. 1862. Échin., p. 535.
" **rosea**! A. AGASS. 1863. Bull. M. C. Z., I. p 24. Acapulco.
" *rosea*! VERRILL, 1871. Notes Radiata, p. 583.
" *picta*! VERRILL. 1871. Trans. Con. Acad., I. p. 581. Gulf of California. La Paz.
Lytechinus roseus! VERRILL, 1867. Notes Radiata, p. 302. Panama Bay.

*Mauritius (Pike); Muscat! (Cook, Essex Inst.); East India! Seychelles! (J. d. P.); New Caledonia! (Crosse); Philippine Islands! (Semper); Keeling! (Stockholm); *Feejee Islands (Mus. Godeff.); Gulf of Persia! Bourbon! (Écol. Min.); Timor, Molucca (Martens); Siguigor! (Brit. Mus.); Japan! (Smithson. Coll.); *Acapulco (A. Agassiz); *Pearl Islands (Bradley, Yale Coll.); Mazatlan! (Vienna, Stockholm, Copenh. Mus.); Panama! La Paz! (Yale Coll.).

Toxopneustes semituberculatus

Echinus **semituberculatus**! VAL. 1846 in AGASS. C. R. Ann. Sc. Nat., VI. p. 368.
Psammechinus *semituberculatus*! AGASS. 1846, C. R. Ann. Sc. Nat., VI. p. 368. Galapagos.
Psammechinus semituberculatus! DUJ. HUPÉ, 1862. Échin, p. 527.
Lytechinus " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 301.
Schizechinus " POMEL, 1869. Revue d. Echin., p. XLII.
Psammechinus **pictus**! VERRILL, 1867. Notes Radiata, p. 301. Cape St. Lucas.
Boletia picta! VERRILL, 1871. Notes Radiata, p. 581. (pars.) La Paz.

*Galapagos Islands; W. coast Cent. Am.! (Stockholm, Bonn Mus.); *Cape St. Lucas (Xanthus, Smithson. Coll.).

Toxopneustes variegatus

...... GUALTERI, 1742. Index Tert., *Pl CVII. f. F.*
Echinus variegatus! (**Lam.**) 1816. An. s. Vert., p. 48 (non Cid. varieg. LESKE). St. Domingo.
" *variegatus*! BLAINV. 1825. Dict. Sc. Nat. O., p. 83.
" " SAY, 1827. Jour. Ac. N. S Phila, p. 225.
" " BLAINV. 1834. Actin., p. 227.
" " ! AGASS. 1836. Prod., p. 23.
" " DESML. 1837. Syn., p. 276.
" " ! RAV. 1848. Cat Ech. So. Ca.
Psammechinus *variegatus*! AGASS. 1846. C. R. Ann. Sc Nat., VI. p. 368. Yucatan.
Psammechinus " ! DUJ. HUPÉ. 1862. Échin, p. 527.
" " ! PERRIER, 1869. Pédic, p. 149.
Lytechinus " ! A. AGASS. 1863. Bull. M. C Z., I. p. 24. Cienfuegos. Hayti.
Lytechinus " ! VERRILL, 1867. Notes Rad., p. 369. Cape Frio. Porto Seguro.
" " ! A. AGASS. 1869. Bull. M. C. Z., I. p. 264. No. Carolina.
Psilechinus " ! LÜTK. 1864. Bid., p. 93.
Echinus **excavatus**! BLAINV. 1825. Dict. Sc. Nat. O., p. 83.
" *excavatus*! BLAINV. 1834. Actin., p. 227.
Psammechinus *excavatus*! AGASS. 1846. C. R. Ann. Sc. Nat., VI. p. 369. Martinique. Brazil.
Psammechinus " ! DUJ. HUPÉ, 1862. Échin., p. 527.
Echinus **Blainvillei** DESML. 1837. Syn., p. 276.
? *Psammechinus* **exoletus** MCCRADY, 1857. Plioc. Foss. So. Ca., *Pl. II. f. 6.*
Anapesus carolinus! HOLMES, 1860. Post Plioc. Foss. So. Ca., *Pl. II. f. 2.* So. Carol'na.
Lytechinus *carolinus*! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Georgia. Florida.
" **atlanticus**! A. AGASS. 1863. Bull. M. C. Z., I. p. 24. Bermudas.
Hemiechinus nobilis GIR. MS. Mus. Smiths. (teste VERRILL).

Toxopneustes variegatus (*continued*).

Schizechinus *variegatus* POMEL, 1869. Rev. d. Echin., p. XLII.
" *excavatus* POMEL, 1869. Rev. d. Echin., p. XLII.
Echinus flammeus MS. (É. M.)

*W. Indies (Ames); *Jamaica (Adams); *Hayti (Weinland, Uhler); *St. Thomas (Thayer Ex.); *Cienfuegos, Cuba (Aviles); *Captiva Key, Fla. (Würdeman); *Port au Prince (Ackerman); *Rio Janeiro (Agassiz, Thayer Exp.); *Armaçao, *Bahia, *Porto Seguro (Hartt & Copeland, Thayer Exp.); *Cape Fear Riv. Bar, 7 fms, *Florida Gulf Stream, 34 fms., *off Sand Key, 24 fms., *Tortugas, 5–7 fms., *Florida Reef (Pourtalès); *Cape Florida (Würdeman); *Gulf of Mexico; *Charleston, S. C. (Agassiz, Gibbes); *Tampa Bay (Conrad); *Isle of Britain, Mouth of Miss. (Peirce); *Beaufort, N. C. (Bickmore); *Bermudas (Hammond, Bickmore); Martinique! Guadeloupe! (J. d. P.); Yucatan! (École. Min.); Cuba! (Arango); Cape Frio, Vittoria (Hartt).

TRIGONOCIDARIS.

Trigonocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Trigonocidaris albida

Trigonocidaris albida! A. AGASS. 1869. Bull. M. C. Z., I. p. 263. Straits Florida.

*Florida Gulf Stream, 98, 123, 125, 130, 138 fms., *off Conch Reef, 40 fms., *off Sand Key, 119, 120, 129, 138, 154 fms., *off Samboes, 125 fms., *off Key West, 135 fms., *off Havana, 270 fms., *off Sombrero, 125 fms. (Pourtalès).

(HEMIASTER.) TRIPYLUS.

Tripylus PHIL. 1845. Wieg. Arch., I.
Agassizia AGASS. 1847. C. R. Ann. Sc. Nat., VIII. (pars)
Brissopsis AGASS. 1847. C. R. Ann. Sc. Nat., VIII. (pars.)
Faorina GRAY, 1851. Ann. Mag. N. H., VII. (pars)
Hamaxitus TROSCH. 1851. Wieg. Arch.

Tripylus excavatus

Tripylus excavatus! PHIL. 1845. Wieg. Arch., I. p. 344, *Pl. XI. f. 1.* So. Extrem. So. Am.
Tripylus (**Hamaxitus**) *excavatus*! TROSCH. 1851. Wieg. Arch., p. 72.
" *excavatus*! GRAY, 1855. Cat. Rec. Echin, p. 59. So. Extrem So. Am.
Agassizia excavata! AGASS. 1847. C. R. Ann. Sc. Nat., VIII. p. 20.
Brissopsis " ! DUJ. HUPÉ, 1862. Échin., p. 597.

*M. C. Z.; Straits of Magellan! (Brit. Mus., Cunningham); So. Extrem. So. Am.! (Brit. Mus.); Chili! (Philippi).

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Hemidiadema Agass. 1846.
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  nobilis Gir. MS. *Toxopneustes variegatus* A. Agass., 168.
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  mascareignarum Mich. **Maretia** *planulata* Gray, 140.
Hemipedina Wright, 1855.
  cubensis A. Agass. *Hemipedina cubensis* A. Agass., 132.
Hemipneustes Agass. 1836.
Hemipygus Etall. 1862.
Heteraster D'Orbig. 1853.
Heterocentrotus Br. 1835.
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  mammillatus Br. **Heterocentrotus** *mammillatus* Br., 133.
  Postellsii Br. **Heterocentrotus** *mammillatus* Br. 133.
  taeniatus Br. **Heterocentrotus** *trigonarius* Br. 134.
  trigonarius Br. **Heterocentrotus** *trigonarius* Br. 134.
Heterocentrus Gray, 1840 (err. typ. **Heterocentrotus** Br.).
  mammillatus Müll. **Heterocentrotus** *mammillatus* Br. 133.
  trigonarius Müll. **Heterocentrotus** *trigonarius* Br. 134.
Heterocidaris Cott. 1860.
Heterodiadema Cott. 1862.
Heterolampas Cott. 1862.
Heteropneustes Pomel, 1869.
Heterosalenia Cott. 1861.
Hipponoë Gray, 1840.
  depressa A. Agass. *Hipponoë depressa* A. Agass., 134.
  esculenta A. Agass. *Hipponoë esculenta* A. Agass., 135.
  nigricans A. Agass. *Hipponoë variegata* A. Agass., 136.
  sardica Gray. *Hipponoë variegata* A. Agass., 135.
  variegata A. Agass. *Hipponoë variegata* A. Agass., 135.
  violacea A. Agass. *Hipponoë variegata* A. Agass., 136.
Holaster Agass. 1836.
Holectypus Des. 1842.
Holocentronotus Gray, 1855 (err. typ. **Heterocentrotus** Br.).
Holopneustes Agass. 1841.
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Hypechinus Des. 1855.
Hypodiadema Des. 1855.
Hyposalenia Des. 1856.
Hypsaster Pomel, 1869.
Hypsoclypus Pomel, 1869.
Hypsopatagus Pomel, 1869.

Infulaster Hagenow, 1851.
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Isaster Des. 1858.

GEOGRAPHICAL DISTRIBUTION.

All that we know of the Geographical Distribution of marine animals is, with the exception of very contracted areas, limited to strictly littoral distribution. It is true that the Deep Sea Dredging Expeditions, since the laying of the Atlantic cable, have given us considerable additional information respecting the geographical distribution of marine life on the bottom of the northern part of the Atlantic, but that is as yet only sketched out roughly, though sufficiently to show us the probable mode of distribution of animals at different depths according to the temperature, forming tolerably well-defined belts, similar to the great belts of distribution of animals and plants as we ascend in altitude or in latitude, though the latter does not form apparently so important a part in the distribution of marine life as in the case of land animals and plants. On land, when we have alpine and arctic assemblages of similar animals and plants occurring in far distant geographical points (latitudinally distant), the identity of forms extends to but few types; while, as far as we can judge from the little we know of the inhabitants of the deeper parts of the Atlantic, the same species have a wide geographical range far exceeding any similar distribution on land. While on land we have a circumpolar arctic fauna extending with outliers at only comparatively short distances on the highest parts of the adjoining temperate tracts, we have probably an abyssal circumpolar marine fauna extending far into the tropics, surrounded at its lowest base (the littoral edges) by faunæ of the most diversified character, — a feature entirely unknown in the distribution of life upon the land. Of course we have the analogous feature of the change of life as we proceed in altitude in a mountain-chain, but that is a homologue of a similar change in marine life as we change the depth; and although we have something analogous to a well-characterized fauna surrounded by widely different elements east and west and north and south in the Rocky Mountains, yet we have nowhere such a diversified condition of life as we find in the littoral elements surrounding what at present we may call the Atlantic Realm, surrounded by the circumpolar littoral

fauna, — the Lusitanian, the West African, the Tropical Atlantic, and the American Boreal forming the base of life as it were of the Atlantic Realm. It is not a little remarkable that the point urged by Sars with so much force (in absence of evidence) against Lovén's theory of the distribution of life, — of a uniform fauna throughout the bottom of the deeper parts of the Atlantic, — should so soon have been disproved by actual exploration; the presence of Rhizocrinus lofotensis, Schizaster fragilis, Homolampas fragilis, Echinus norvegicus, Dorocidaris papillata, Echinocyamus pusillus, at such widely distant points and with such great bathymetrical range, shows that the theory proposed by Lovén gives, as far as we know, a rational explanation of many phenomena hitherto imperfectly understood in the distribution of marine life in the different bathymetrical belts. The explorations now going on under the auspices of the United States Coast Survey will probably extend our knowledge on this subject so materially that it seems useless to attempt any further exposition of the subject till their results are available, and I will limit myself, in discussing the geographical distribution of Echini, to strictly littoral divisions; not that I do not expect the material likely to be collected will not modify to some extent the limits assigned to the littoral divisions here sketched out, but in the main they are likely to be tolerably correct, if we may judge from the nature of the material thus far brought together in different public museums of Europe and America by the exploring expeditions sent at different times during this century by all the great continental nations. They have explored more or less thoroughly the shore lines at least of the greater part of the world, leaving but few spots about which we actually know nothing, so far at least as the distribution of Echini is concerned. It was, indeed, a matter of great surprise to find how few species of Echini hitherto not noticed were not to be found in the vast stores of the British Museum, the Jardin des Plantes, the Museums of Copenhagen, Stockholm, Berlin, Vienna. Everywhere, although from different localities, were found repetitions of species already well known, so that in making a map of the littoral regions we find but short stretches of shores completely unexplored. Of course additional species will undoubtedly turn up even in the best explored localities, but we have probably a very fair representation of the littoral Echini of the world.

In following out the geographical distribution of such a limited order as the Echini, we have the great advantage of being able to carry in our mind

the exact range of each species, and thus to see how far the limits of the littoral faunæ recognized among Mollusca by Forbes and Woodward, and among Crustacea by Dana, can be accepted for the Echini. Our limitation of a fauna seems as arbitrary as that of a geological period. We take a certain assemblage of animals at any special point, and, contrasting them with a different adjoining assemblage, frequently conclude that because we find differences we are entitled to consider this a different fauna. Such may or may not be the case on a more careful analysis of the range of the elements composing these two assemblages, but too often it will turn out, when carefully analyzed, that what we call a fauna is simply an overlapping of the range of two more distant faunæ, giving the intermediate district a peculiar physiognomy not always readily separable into its constituent elements, either from want of material or from imperfect identifications. It is frequently almost impossible to determine to which littoral district certain points belong, from the even balance held by the elements of the various districts found there. At the Cape Verde Islands we find a nearly equal number of species known to inhabit the Mediterranean, the West Indies, and tropical Africa; but there is no reason for making a special fauna of that part of the coast, any more than the mingling of the arctic species of the west coast of Norway with the Lusitanian, British, and even Mediterranean or Atlantic species, entitles the Scandinavian shores to rank as a littoral fauna. Nor does the presence of Arctic, West Indian, and boreal American species south of Cape Cod entitle that region to form a special littoral fauna. It has nothing peculiarly its own, as far as Echini are concerned, and is simply an assemblage of species ranging far beyond the limits which the greater number of species have. It is our ability thus to eliminate foreign elements which will give our divisions greater or less accuracy. Nor does the presence of Atlantic species along the Virginia and North Carolina coast, associated with West India species, entitle this region to be considered as a special faunistic littoral division. It is a very peculiar littoral district, as much so as the one immediately south of Cape Cod; but it is an assemblage of foreign elements which, although they apparently give to the coast of South Carolina, north and south, a very peculiar aspect, so far as its Echini fauna is concerned, is yet made up of species (component elements) having a very wide geographical distribution, and forming parts of totally different combinations. It may be useful to have names for these assemblages, but they have no biological value. At first glance the presence of

Echinarachnius parma on the east coast of North America strikes us as very characteristic of a Canadian fauna, yet when we remember that it is found on both sides of North America and on the east side of Asia, extending probably far south into the great Indo-Pacific Littoral Realm, we at once see that although we have on the east coast of North America several of these littoral assemblages, we have in reality only two faunæ, one the Circumpolar, the other the West Indian, which meet at Cape Cod, and by combination with the Pacific Boreal, the Lusitanian, the Atlantic, and the Mediterranean, form littoral assemblages which have thus far received the name of faunæ, but are evidently not entitled to it.

The Littoral Districts, which have been mapped out on *Pl. A* and *B*, are not made from any preconceived notions, but have been taken from the distribution of the several species of the annexed lists. We cannot fail to be struck with the remarkable coincidence of the great belts of temperature first mapped out by Dana, which are here copied from his map on the geographical distribution of Crustacea, and the approximate limits of many of our littoral districts, — an agreement which is still more striking when we come to examine the range of the principal genera.

The number of littoral districts recognized is considerably smaller than the number of provinces adopted by Forbes, Woodward, and Dana, the principal writers on the limits of marine geographical provinces. This is due in part to the smaller number of species of Echini, but the principal cause of the extensive range of so many species must be looked for in the influence of the currents.

The effect which currents play in shaping the geographical distribution of marine animals is very great; we have an example in the Gulf Stream and the northern branch of the Amazonian current flowing into the Gulf of Mexico, which account fully for the great range of the more common littoral species. The Japanese current makes itself felt as far as San Diego, two species of Echini extending in the Northern Pacific from the northern part of Japan along Kamtchatka, the Aleutian Islands, Sitka, Vancouver's Island, the one as far as Cape Mendocino (S. Dröbachiensis), the other (Echinarachnius excentricus) to San Diego. The Indo-Pacific equatorial current has undoubtedly been the main agent of the extensive geographical range of such species as Cidaris metularia, Echinonëus cyclostomus, Heterocentrotus mammillatus, Diadema setosum, Hipponoë variegata, Echinolampas oviformis, Brissus carinatus, Clypeaster humilis.

The effect of currents in thus extending the distribution of marine animals would act very differently upon the several classes of the animal kingdom, and its efficiency depends to a great extent upon the nature of their earlier stages, and upon their habits during that period. The time during which the Pluteus of Echini remains helpless at the mercy of the winds and currents is considerable; from early spring till late in the summer or fall is the usual time required for the full growth of the Pluteus in many species of Sea-urchins, and the distance which the young could thus be transported, even by a sluggish current, during a single season, must be considerable, even under the most unfavorable circumstances.

As many Echini are not affected by a great range of depth (1200 fathoms), and reproduce themselves frequently at the end of the third year, and even of the second year, after the resorption of the Pluteus, it is not astonishing the same species should be found in every extreme position of depth, latitude, and longitude.

Various writers have attempted to retrace, in former geological periods, the probable course of the currents and their effect upon the geographical distribution of marine animals; they all agree in representing, up to the Cretaceous period, an unbroken equatorial current, passing through Central Asia, Arabia, the northern part of Africa, and connecting with the Pacific by a narrow strait through the Isthmus of Panama. The existence of this connection in the Cretaceous period is placed beyond doubt by the presence of an Ananchytes, which I am unable to distinguish from Ananchytes radiata, collected on the Isthmus of Panama, and now in the possession of Yale College, kindly loaned me for examination by Professor Verrill. From the small number of identical species, either of Mollusca, Crustacea, or Fishes, recorded on both sides of the Isthmus, this connection must have been very imperfect at a comparatively recent geological period,— since the existence of the present faunæ.

The question naturally arises, Have we not in the different faunæ of both sides of the Isthmus a standard by which to measure the changes which these species have undergone since the raising of the Isthmus of Panama and the isolation of the two faunæ? If the upheaval of the Isthmus has been gradual, it must, of course, have cut off the deep-water species on both sides of the Isthmus, and gradually have isolated the more shallow, till the littoral species also became separated. As a natural consequence, the deeper we go, the farther back in time we must expect to find the representation,

— a result which is strikingly confirmed by the nature of the deep-water fauna of the West Indies. Unfortunately we have not, as in the case of the littoral faunæ, a standard of comparison. At the same time, with the gradual closing of the Isthmus of Panama, the greater part of Central Asia, of the Arabian Peninsula, and of Northern Africa was emerging from the sea, reducing the range of the equatorial current, and thus confining the course of the currents much as they are at the present time. This would thus cause a limitation in the range of the species formerly having the greatest distribution, and extend that of those which were more local.

If migration on land when continents were joined together, and subsequent variations after their isolation through submergence, has been the main agent in the distribution of the existing terrestrial faunæ, we must acknowledge a similar agency to currents in the distribution of marine faunæ; and by the submergence or rise of various portions of the continents, we shall be able, if we can trace these changes, to reconstruct within certain limits the altered courses of the main oceanic currents, and get some idea of the probable geographical distribution at different geological epochs. The greater the bathymetrical range of littoral species, the longer will such species remain unaffected, while deep-sea species may early become isolated and remain as outliers as it were, — mementoes of a former condition of currents, or even of a previous geological period. The careful analysis of the fauna of a given point, its comparison with other faunæ, and accurate bathymetrical data, would go far towards reconstructing the Natural History of the sea in former ages, and showing its relation to the present and past times.

The representative species of Echinus, Echinocardium, Brissopsis, Schizaster, in the Arctic and Antarctic boreal zones would be considered as the living representatives of a cosmopolitan fauna existing at the time when the great equatorial current flowed unbroken round the globe, sending branches north and south along Eastern North and South America, along Eastern Japan and Australia, and the Eastern Coast of Africa; while the tropical species of the genera Diadema, Clypeaster, Echinonëus, Echinolampas, etc., existing at that time, had a more limited equatorial geographical distribution. The subsequent period of isolation of Atlantic and Pacific currents is shown by the existence of truly Atlantic and Pacific species; while as we go down in depth we go back also in time, and find at first representatives of the genera found in our Tertiaries, while at greater depth the species are

representatives of genera found in the Cretaceous. A more detailed comparison than can be given here of the present faunæ with the fossils of the tertiary deposits, would be most interesting; but unfortunately the materials thus far collected are too fragmentary, and we must await deep-sea dredgings of a considerable extent of coast, before we shall have the data needed to follow up the important results to be gained in this way for palæontology and geography, of which our present incomplete materials give us such an interesting glimpse.

What we know of the Tertiaries of the West Indies and Alabama, of Malta and of India, shows that with the exception of the greater extension of Echinanthus, Eupatagus, Maretia, Scutella, Pygorhynchus, the North Atlantic fauna did not differ very materially from its present conditions. The same may be said of the American; while the Tertiaries of the East Indies show the presence of Temnopleurus, Pleurechinus, Heliocidaris, Rumphia, Breynia, Maretia,—genera which are still characteristic of the same districts.

As far as we can judge from the present geographical extension of the genera characteristic of the different great Marine Realms, we can only recognize four (*Pl. G*); the American, the coasts of the two sides of this continent (north and south), being characterized by Echinarachnius, Arbacia, Encope, Mellita, Hemiaster. The species of this realm extend as far as the Mediterranean and the West Coast of Africa, where they unite with the species of the North Atlantic Realm, Echinus, Sphaerechinus, Schizaster, Strongylocentrotus, Dorocidaris, Spatangus, Echinocyamus, Echinocardium, and extend along the Japanese coast to meet the great Indo-Pacific Realm; the Atlantic Realm extending through the Red Sea, Indian Ocean, to Japan, forming a belt of species, Schizaster, Sphaerechinus, Echinocardium, Spatangus, now disconnected from the North Atlantic Realm except by the circumpolar species, which, however, does not show the former association, through the Red Sea and North Africa, as well as the existence of the above-mentioned genera associated with thoroughly characteristic Indo-Pacific species. We must look upon the great extension of the genus Strongylocentrotus along the whole of the West Coast of North and South America and of Echinocardium as indicating a possible genetic connection between the species of the Arctic and Antarctic Seas.

The characteristic genera of the Indo-Pacific Realm are Phyllacanthus, Colobocentrotus, Heterocentrotus, Paraselenia, Fibularia, Echinostrephus, Laganum, Maretia. This realm is connected with the American Realm by the

genera Clypeaster, Echinanthus, Metalia, Cidaris, Diadema, Echinometra, and with the North Atlantic by the genera mentioned above, Echinocardium and Strongylocentrotus.

The fourth realm, the Australian, differs radically from the others, and remains more completely isolated from the other existing realms. Though it is associated by Centrostephanus and Breynia with the Indo-Pacific, and by Strongylocentrotus and Echinocardium with the North Atlantic Realm, the South Circumpolar District must be considered a part of this realm (by Goniocidaris canaliculatus), as we have looked upon the North Circumpolar District as a part of the North Atlantic Realm.

The principal Isochrymal Lines dividing the oceans into Frigid, Temperate, and Torrid are copied from Professor Dana's Isochrymal Lines, given by him on his valuable map of the Geographical Distribution of Crustacea, in his great work on the Crustacea of the United States Exploring Expedition.

PLATE A, contains the following Littoral Districts, — Pacific, Boreal American, West South American, Tropical Atlantic, West Africa, Indo-Africa, Indo-Pacific, North Circumpolar, Patagonia.

PLATE B, — Japanese, Australian, North Pacific, Panamic, North Atlantic, Lusitanian, South Circumpolar, East Indian, Californian.

PLATE G, shows the Distribution of the Oceans into four great Realms, — Atlantic Circumpolar, Australian Antarctic, Pacific, and American.

LIST OF THE KNOWN SPECIES OF ECHINI.

DESMOSTICHA Haeckel.

CIDARIDAE Müll.

GONIOCIDARIDAE Haeckel.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Cidaris Kl.		
Cidaris metularia Bl.	*Cidarites* **metularia** Lamk.	Red Sea; Mauritius; E. India Isls.; Sandwich Isls.; Feejee Isls.
Cidaris **Thouarsii** Val.	*Cidaris* **Thouarsii** Val.	Panama; Gulf of California.
Cidaris tribuloides Bl.	*Cidarites* **tribuloides** Lamk.	Florida; Brazil; Cape Palmas.
Dorocidaris A. Agass.		
Dorocidaris *papillata* A. Ag.	*Cidaris* **papillata** Leske.	Norway; Mediterranean; Fla.
Phyllacanthus Br.		
Phyllacanthus annulifera A. Ag.	*Cidarites* **annulifera** Lamk.	Australia; Philippine Isls.
Phyllacanthus baculosa A. Ag.	*Cidarites* **baculosa** Lamk.	Red Sea; Zanzibar; Mauritius.
Phyllacanthus dubia Br.	**Phyllacanthus dubia** Br.	Zanzibar; Bonin Isls.; Australia.
Phyllacanthus gigantea A. Ag.	**Chondrocidaris gigantea** A. Ag.	Sandwich Isls.
Phyllacanthus *imperialis* Br.	**Cidaris Mauri**...... Kl.	Red Sea; East India Isls.; Australia.
Phyllacanthus verticillata A. Ag.	*Cidarites* **verticillata** Lamk.	Society Isls.; East India Isls.; Australia.
Stephanocidaris A. Agass.		
Stephanocidaris bispinosa A. Ag.	*Cidarites* **bispinosa** Lamk.	Australia; Malacca.
Porocidaris Des.		
Porocidaris **purpurata** W. Thom.	*Porocidaris* **purpurata** W. Thom.	Rockall.
Goniocidaris Des.		
Goniocidaris canalicuta A. Ag.	*Temnocidaris* **canaliculata** A. Ag.	Patagonia; Natal.
Goniocidaris *geranioides* Ag.	*Cidarites* **geranioides** Lamk.	Australia; E. Indies.
Goniocidaris tubaria Lütk.	*Cidarites* **tubaria** Lamk.	Australia; Tasmania.

SALENIDAE Agass.

Salenia Gray.		
Salenia varispina A. Ag.	**Salenocidaris varispina** A. Ag.	Straits of Florida.

ARBACIADAE Gray.

Arbacia Gray.		
Arbacia *Dufresnii* Gray.	*Echinus* **Dufresnii** Bl.	Patagonia; Chili.
Arbacia nigra A. Ag.	*Echinus niger* (**Mol.**)	Patagonia; Chili; Peru.
Arbacia *punctulata* Gray.	*Echinus* **punctulatus** Lamk.	Long Island Sound to W. Florida.
Arbacia *pustulosa* Gray.	*Cidaris* **pustulosa** Leske.	Mediterranean; Liberia; Brazil.
Arbacia spatuligera A. Ag.	*Echinus* **spatuliger** Val.	Chili; Peru.
Arbacia *stellata* Gray.	*Echinus stellatus* (**Bl.**)	Panama; Gulf of California.
Podocidaris A. Agass.		
Podocidaris sculpta A. Ag.	**Podocidaris sculpta** A. Ag.	Straits of Florida.
Coelopleurus Agass.		
Coelopleurus **floridanus** A. Ag.	*Coelopleurus* **floridanus** A. Ag.	Straits of Florida.
Coelopleurus Maillardi A. Ag.	**Keraiaphorus Maillardi** Mich.	Bourbon.

DIADEMATIDAE Peters.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Diadema Schynv.		
Diadema **mexicanum** A. Ag.	*Diadema* **mexicanum** A. Ag.	Acapulco; Cape St. Lucas.
Diadema setosum Gray.	*Cidarites diadema* Lamk.	W. India Isls.; Cape Verde Isls.; Indian Ocean; Japan; Sandwich Isls.; Feejee Isls.
Centrostephanus Pet.		
Centrostephanus coronatus A. Ag.	**Echinodiadema coronata** Ver.	Cape St. Lucas.
Centrostephanus *longispinus* Pt.	*Diadema* **longispina** Phil.	Palermo; Canary Isls.
Centrostephanus Rodgersii A. Ag.	**Thrichodiadema Rodgersii** A. Ag.	Australia; New Caledonia.
Echinothrix Pet.		
Echinothrix calamaris A. Ag.	*Echinus* **calamaris** Pall.	Society Isls.; East India Isls.; Philippine Isls.
Echinothrix *Desorii* Pet.	*Astropyga* **Desorii** Agass.	Red Sea; Feejee Isls.; Sandwich Isls.
Echinothrix *turcarum* Pet.	**Diadema turcarum** Schynv.	Sandwich Isls.; Feejee Isls.; Japan; E. India Isls.; Red Sea; Zanzibar.
Astropyga Gray.		
Astropyga pulvinata Agass.	*Cidarites* **pulvinata** Lamk.	Panama; Gulf of California.
Astropyga *radiata* Gray.	*Cidaris* **radiata** Leske.	Zanzibar; East India Isls.; Philippine Isls.
Asthenosoma Grube.		
Asthenosoma hystrix A. Ag.	**Calveria hystrix** Thom.	Florida; Rockall to Rona.
Asthenosoma varium Grube.	**Asthenosoma varium** Grube.	China Seas.

ECHINOMETRADAE Gray.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Colobocentrotus Br		
Colobocentrotus *atratus* Br.	*Echinus* **atratus** Linn.	Zanzibar; Java; Sandwich Isls.
Colobocentrotus Mertensii Br.	**Colobocentrotus Mertensii** Br.	Bonin Isls.; Australia.
Heterocentrotus Br.		
Heterocentrotus *mammillatus* Br.	**Cidaris mammillata** Kl.	Sandwich Isls.; E. India Isls; Red Sea; Feejee Isls.
Heterocentrotus *trigonarius* Br.	*Echinus* **trigonarius** Lamk.	Mauritius; Java; Sandwich Isls.; Feejee Isls.
Echinometra Rondel. (Breyn.)		
Echinometra lucunter Bl.	*Cidaris lucunter* Leske.	Zanzibar; Red Sea; E. India Isls.; Japan; Sandwich Isls.; Feejee Isls.
Echinometra macrostoma A. Ag.	**Ellipsechinus macrostomus** Lutk.	
Echinometra oblonga Bl.	*Echinus* **oblongus** Bl.	Sandwich Isls.; Philippine Isls.; Seychelle Isls.
Echinometra subangularis Desml.	*Cidaris* **subangularis** Leske.	Senegal; Cape Verde; Brazil; W. India Isls.; Bermudas.
Echinometra **Van Brunti** A. Ag.	*Echinometra* **Van Brunti** A. Ag.	Peru; Panama; Gulf of Cal.
Echinometra **viridis** A. Agass.	*Echinometra* **viridis** A. Ag.	Florida; Hayti.
Parasalenia A. Agass.		
Parasalenia gratiosa A. Ag.	**Parasalenia gratiosa** A. Ag.	Kingsmills Isls.; Bonin Isls.; Zanzibar.
Stomopneustes Agass.		
Stomopneustes *variolaris* Ag.	*Echinus* **variolaris** Lamk.	Mauritius, Java; Samoa.
Strongylocentrotus Br.		
Strongylocentrotus albus A. Ag.	*Echinus* **albus** Mol.	Patagonia; Chili; Peru.
Strongylocentrotus **armiger** A. Ag.	*Strongylocentrotus* **armiger** A. Ag.	Australia.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Strongylocentrotus Br. (*continued*).		
Strongylocentrotus depressus A. Ag.	*Toxocidaris* **depressa** A. Ag.	Japan.
Strongylo. Dröbachiensis A. Ag.	*Echinus* **Dröbachiensis** Müll.	N. European; N. Pacific; N. E. Coast of America.
Strongylo. eurythrogrammus A. Ag.	*Echinus* **eurythrogrammus** Val.	Australia; Tasmania; Samoa.
Strongylo. franciscanus A. Ag.	**Toxocidaris franciscana** A. Ag.	Formosa; Puget Sd.; San Diego.
Strongylocentrotus Gaimardi A. Ag.	*Echinus* **Gaimardi** Bl.	Brazil.
Strongylocentrotus gibbosus A. Ag.	*Echinus* **gibbosus** Val.	Chili; Galapagos; Peru.
Strongylo. intermedius A. Ag.	*Psammechinus* **intermedius** Barn.	Japan.
Strongylocentrotus *lividus* Br.	*Echinus saxatilis* Lin.	Europ. Atlantic; Mediterranean; Azores.
Strongylocentrotus mexicanus A. Ag.	**Toxocidaris** *mexicana* (**A. Ag.**)	Gulf of California.
Strongylocentrotus nudus A. Ag.	*Toxocidaris* **nuda** A. Ag.	Sandwich Isls.; Japan.
Strongylo. purpuratus A. Ag.	*Echinus* **purpuratus** Stimps.	San Francisco; Puget Sound.
Strongylo. *tuberculatus* Br.	*Echinus* **tuberculatus** Lamk.	Japan; China; Australia; New Zealand.
Sphaerechinus Des.		
Sphaerechinus **Australiae** A. Ag.	*Sphaerechinus* **Australiae** A. Ag.	Australia; Mauritius; New Zealand.
Sphaerechinus granularis A. Ag.	*Echinus* **granularis** Lam.	Mediterranean; Canary Isls.
Sphaerechinus pulcherrimus A. Ag.	*Psammechinus* **pulcherrimus** Barn.	Japan; China Seas.
Pseudoboletia Trosch.		
Pseudoboletia granulata A. Ag.	*Boletia* **granulata** A. Ag.	Sandwich Isls.
Pseudoboletia indiana A. Ag.	*Toxopneustes* **indianus** Mich.	Philippine Isls: Mauritius.
Echinostrephus A. Agass.		
Echinostrephus molare A. Ag.	*Echinometra* **setosa** Rumph.	Society Isls.; Zanzibar; Natal.

ECHINIDAE Agass.

TEMNOPLEURIDAE Des.

Temnopleurus Agass.		
Temnopleurus Hardwickii A. Ag.	**Toreumatica Hardwickii** Gray.	Japan.
Temnopleurus **Reynaudi** Ag.	*Temnopleurus* **Reynaudi** Agass.	Ceylon; China Seas.
Temnopleurus *toreumaticus* Ag.	**Cidaris toreumatica** Kl.	Bombay; E. India Isls.; China.
Pleurechinus Agass.		
Pleurechinus *bothryoides* Ag.	**Pleurechinus** *bothryoides* Ag.	Galapagos. ? ?
Temnechinus Forbes.		
Temnechinus maculatus A. Ag.	**Genocidaris maculata** A. Ag.	Straits of Florida; Azores.
Microcyphus Agass.		
Mycrocyphus **maculatus** Ag.	*Microcyphus* **maculatus** Agass.	Japan; Navigator Isls.; East India Isls.
Microcyphus **zigzag** Ag.	**Cidaris bothryoides** Kl.	Japan; Philip. Isls.; Tasmania.
Trigonocidaris A. Agass.		
Trigonocidaris albida A. Ag.	**Trigonocidaris albida** A. Ag.	Straits of Florida.
Salmacis Agass.		
Salmacis bicolor Ag.	**Salmacis bicolor** Agass.	R'd Sea; Mozambique; Bombay.
Salmacis **Dussumieri** Ag.	*Salmacis* **Dussumieri** Agass.	China Seas.
Salmacis **globator** Ag.	*Salmacis* **globator** Ag.	Australia.
Salmacis **rarispina** Ag.	*Salmacis* **rarispinus** Agass.	Philippine Isls.; Siam; China Seas.
Salmacis **sulcata** Ag.	*Salmacis* **sulcatus** Agass.	Australia; Philippine Isls.; Mozambique; Red Sea.
Mespilia Des.		
Mespilia *globulus* Ag.	*Echinus* **globulus** Lin.	Japan; Philippine Isls.; Sandwich Isls.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Amblypneustes Agass.		
Amblypneustes *griseus* Ag.	*Echinus* **griseus** Bl.	Australia; New Zealand.
Amblypneustes **formosus** Val.	*Amblypneustes* **formosus** Val.	Australia.
Amblypneustes ovum Ag.	*Echinus* **ovum** Lamk.	Australia.
Amblypneustes pallidus Val.	*Echinus* **pallidus** Lamk.	Australia; Feejee Isls.
Amblypneustes **pentagonus** A. Ag.	*Amblypneustes* **pentagonus** A. Ag.	Mauritius. ?
Holopneustes Agass.		
Holopneustes inflatus A. Ag.	*Amblypneustes* **inflatus** Lütk.	New Holland.
Holopneustes **porosissimus** Ag.	*Cidaris granulata* (**Agass.**)	New Holland.
Holopneustes purpurescens A. Ag.	*Amblypneustes* **purpurescens** Lütk.	New Holland.
	TRIPLECHINIDAE A. Agass.	
Phymosoma Haime.		
Phymosoma crenulare A. Ag.	**Glyptocidaris crenularis** A. Ag.	Japan.
Hemipedina Wright.		
Hemipedina cubensis A. Ag.	**Caenopedina cubensis** A. Ag.	Straits of Florida.
Echinus Rond. (Linn.)		
Echinus **acutus** Lamk.	*Echinus* **acutus** Lamk.	Norway; Mediterranean.
Echinus angulosus A. Ag.	*Cidaris* **angulosa** Lekse.	Cape Good Hope; Mauritius; Red Sea; Philippines; New Zealand.
Echinus elegans Düb. o. Kor.	*Echinus elegans* (**Düb. o. Kor.**)	Norway; off Valencia; Mediterranean.
Echinus esculentus Lin.	*Echinus* **subglobosus** Linn.	Norway; English Channel.
Echinus **gracilis** A. Ag.	*Echinus* **gracilis** A. Ag.	Straits of Florida; St. Thomas.
Echinus **magellanicus** Phil.	*Echinus* **magellanicus** Phil.	Patagonia; Chili; New Zealand.
Echinus **margaritaceus** Lam.	*Echinus* **margaritaceus** Lamk.	Patagonia.
Echinus **melo** Lam.	*Echinus* **melo** Lamk.	Mediterranean.
Echinus **microtuberculatus** Bl.	*Echinus* **microtuberculatus** Bl.	Mediterranean; Cape Verde Isls.
Echinus **miliaris** Müll.	*Echinus* **miliaris** Müll. Kn.	Norway; English Channel.
Echinus **norvegicus** Düb. o. Kor.	*Echinus* **norvegicus** Düb. o. Kor.	Norway; off Valencia; Mediterranean; Straits of Florida.
Toxopneustes Agass.		
Toxopneustes maculatus A. Ag.	*Echinus* **maculatus** Lamk.	Christmas Isl.; Bourbon.
Toxopneustes *pileolus* Agass.	*Echinus* **pileolus** Lamk.	Panama; E. India Isls.; Feejee Isls.; Mauritius.
Toxopneustes semituberculatus Ag	*Echinus* **semituberculatus** Val.	Galapagos; W. coast Cent. Am.; Cape St. Lucas.
Toxopneustes variegatus A. Ag.	*Echinus variegatus* (**Lamk.**)	Bermudas; S. Carolina; W. India Isls.; Brazil.
Hipponoë Gray.		
Hipponoë depressa A. Ag.	*Tripneustes* **depressus** A. Ag.	Gulf of California.
Hipponoë esculenta A. Ag.	*Cidaris esculenta* (**Leske.**)	Florida; W. Indies; Surinam.
Hipponoë variegata A. Ag.	*Cidaris* **variegata** Leske.	Sandwich Isls.; Japan, E. India Isls.; Feejee Isls.; Red Sea; Mozambique.
Evechinus Verrill.		
Evechinus *chloroticus* Verrill.	*Echinus* **chloroticus** Val.	New Zealand.

CLYPEASTRIDAE Agass.

EUCLYPEASTRIDAE Haeckel.

FIBULARINA Gray.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Echinocyamus Van Phels.		
Echinocyamus pusillus Gray.	**Spatagus pusillus** Müll.	Norway; Mediterr'an; Azores; Florida.
Fibularia Lamk.		
Fibularia **australis** Desml.	*Fibularia* **australis** Desml.	Sandwich Isls.; Japan; Australia.
Fibularia *ovulum* Lamk.	*Echinus* **minutus** Pall.	Indian Ocean; Philippine Isls.
Fibularia **volva** Agass.	*Fibularia* **volva** Agass.	Red Sea; Formosa; N. Australia.

ECHINANTHIDAE A. Agass.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Clypeaster Lamk.		
Clypeaster humilis A. Ag.	*Echinanthus* **humile** Leske.	Red Sea; E. India Isls.; New Caledonia.
Clypeaster rotundus A. Ag.	**Stolonoclypus rotundus** A. Ag.	Panama; San Diego.
Clypeaster scutiformis Lamk.	*Echinus* **reticulatus** Lin. (pars.)	Red Sea; Philippine Isls.; Kingsmills Isls.
Clypeaster subdepressus Agass.	*Echinanthus* **subdepressus** Gray.	Florida; W. coast of Africa.
Echinanthus Breyn.		
Echinanthus rosaceus Gray.	*Echinus* **rosaceus** Lin.	W. India Isls.; Florida.
Echinanthus **testudinarius** Gray.	*Echinanthus* **testudinarius** Gray.	Australia; Japan; Sandwich Isls.; Gulf of California.

LAGANIDAE Des. (Emend.)

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Laganum Kl.		
Laganum Bonani Kl.	**Laganum Bonani** Kl.	Tasmania; E. India Isls.; Philippine Isls.
Laganum **depressum** Less.	*Laganum* **depressum** Less.	Kingsmills Isls.; Feejee Isls; Philippine Isls.; Australia; Zanzibar.
Laganum **Putnami** Barn.	*Laganum* **Putnami** Barn.	Japan.
Peronella Gray.		
Peronella decagonalis A. Ag.	*Scutella* **decagonalis** Bl.	Japan; New Caledonia; Bay of Bengal.
Peronella orbicularis A. Ag.	*Echinodiscus* **orbicularis** Leske.	New Holland; Formosa.
Peronella *Peronii* Gray.	*Laganum* **Peronii** Agass.	Tasmania; Philippine Isls.
Peronella rostrata A. Ag.	*Laganum* **rostratum** Agass.	New Zealand; Zanzibar.

SCUTELLIDAE Agass.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Echinarachnius Leske.		
Echinarachnius excentricus Val.	*Scutella* **excentrica** Esch.	California; Kamtchatka.
Echinarachnius mirabilis A. Ag.	**Scaphechinus mirabilis** A. Ag.	Japan.
Echinarachnius parma Gray.	**Scutella parma** Lamk.	New Jersey; Labrador; Vancouver Isl.; Kamtchatka.
Arachnoides Kl.		
Arachnoides placenta Agass.	*Echinus* **placenta** Lin.	New Zealand; Australia; East India Isls.; Burmah.
Echinodiscus Breyn.		
Echinodiscus **auritus** Leske.	*Echinodiscus* **auritus** Leske.	Zanzibar; Philippine Isls.
Echinodiscus biforis A. Ag.	*Echinodiscus* **bisperforatus** Leske.	Mozambique; Red Sea; Java.
Echinodiscus laevis A. Ag.	**Mellita laevis** Kl.	Japan; New Caledonia; East India Isls.; S. Africa.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Mellita Kl.		
Mellita erythraea Gray.	*Mellita* erythraea Gray.	Red Sea. ?
Mellita longifissa Mich.	*Mellita* longifissa Mich.	Panama; Gulf of California.
Mellita pacifica Verrill.	*Mellita* pacifica Verrill.	Peru.
Mellita sexforis A. Ag.	*Echinus* hexaporus Gmel.	W. India Isls.
Mellita Stokesii A. Ag.	*Encope* Stokesii Agass.	Guayaquil; Panama.
Mellita testudinata Kl.	Mellita testudinata Kl.	Brazil; W. India Isls; North and South Carolina.
Astriclypeus Verrill.		
Astriclypeus Manni Verrill.	Astriclypeus Manni Verrill.	China; Japan.
Rotula Kl.		
Rotula Augusti Kl.	Rotula Augusti Kl.	Liberia.
Rotula Rumphii Kl.	Rotula Rumphii Kl.	Senegal; Cape Verde Isls.
Encope Agass.		
Encope californica Verrill.	*Encope* californica Verrill.	Gulf of California.
Encope emarginata Agass.	*Echinodiscus* emarginatus Leske.	Brazil; West Indies.
Encope grandis Agass.	Encope grandis Agass.	Gulf of California.
Encope Michelini Agass.	*Encope* Michelini Agass.	Yucatan; Florida.
Encope micropora Agass.	*Encope* micropora Agass.	Panama; Gulf of California.

PETALOSTICHA Haeckel.

CASSIDULIDAE Agass.

ECHINONIDAE Agass.

Echinonëus Van Phel.		
Echinonëus cyclostomus Leske.	*Echinoneus* cyclostomus Leske.	Australia; Kingsmills Isls.; Zanzibar.
Echinonëus semilunaris Lamk.	*Echinus* semilunaris Gmel.	Florida; W. India Isls.

NUCLEOLIDAE Agass.

Neolampas A. Agass.		
Neolampas rostellata A. Ag.	Neolampas rostellatus A. Ag.	Straits of Florida.
Echinolampas Gray.		
Echinolampas depressa Gray.	*Echinolampas* depressus Gray.	Straits of Florida.
Echinolampas Hellei Val.	*Echinolampas Richardi* (Desml.)	Senegal.
Echinolampas *oviformis* Gray.	Scutum ovatum Kl.	Red Sea; Molucca.
Rhynchopygus D'Orbig.		
Rhynchopygus caribaearum Lütk.	Cassidulus caribaearum Lamk.	W India Isls.
Rhynchopygus pacificus A. Ag.	*Pygorhynchus* pacificus Ag.	Galapagos; Panama; Gulf of California.
Echinobrissus Breyn.		
Echinobrissus recens D'Orb.	*Nucleolites* recens Edw.	New Zealand; Madagascar.
Nucleolites Lamk.		
Nucleolites epigonus Mart.	*Nucleolites* epigonus Mart.	E. India Isls.
Anochanus Grube.		
Anochanus sinensis Grube.	Anochanus sinensis Grube.	East India Isls.

SPATANGIDAE Agass.

ANANCHYTIDAE Alb. Gras.

Pourtalesia A. Agass.		
Pourtalesia miranda A. Ag.	Pourtalesia miranda A Ag.	Straits of Florida; Shetland Channel.
Homolampas A. Agass.		
Homolampas *fragilis* A. Ag.	*Lissonotus* fragilis A. Ag.	Straits of Florida.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Platybrissus GRUBE.		
Platybrissus Roemeri GRUBE.	**Platybrissus Roemeri** GRUBE.	
	EUSPATANGINA A. AGASS.	
Spatangus KL.		
Spatangus **Lütkeni** A. AG.	*Spatangus* **Lütkeni** A. AG.	Japan.
Spatangus purpureus LESKE.	**Spatagus purpureus** MÜLL.	Norway; Mediterranean.
Spatangus **Raschi** LOVÉN.	*Spatangus* **Raschi** LOVÉN.	German Ocean; Azores; off Valencia.
Maretia GRAY.		
Maretia **alta** A. AG.	*Maretia* **alta** A. AG.	Japan.
Maretia *planulata* GRAY.	*Spatangus* **ovatus** LESKE.	Kingsmills Isls.; China; East India Isls.; New Caledonia; Mauritius.
Eupatagus AGASS.		
Eupatagus Valenciennesii AG.	**Eupatagus Valenciennesii** AG.	Australia.
Lovenia DES.		
Lovenia **cordiformis** LÜTK.	*Lovenia* **cordiformis** LÜTK.	Guyaquil; Gulf of California.
Lovenia elongata GRAY.	*Spatangus* **elongatus** GRAY.	Red Sea; Australia; Philippine Isls.
Lovenia subcarinata GRAY.	*Spatangus* **subcarinatus** GRAY.	China; Luzon; Japan; Sandwich Isls.
Breynia DES.		
Breynia Australasiae GRAY.	*Spatangus* **Australasiae** LEACH.	Red Sea; Australia; Japan.
Echinocardium GRAY.		
Echinocardium **australe** GRAY.	*Echinocardium* **australe** GRAY.	New Zealand; Japan; E. India; Cape Good Hope.
Echinocardium cordatum GRAY.	*Echinus* **cordatus** PENN.	Norway; Mediterranean; Brazil; Florida.
Echinocardium flavescens A. AG.	**Spatagus flavescens** MÜLL.	Norway; S. Carolina; Florida.
Echinocard. mediterraneum GRAY.	*Amphidetus* **mediterraneus** FORB.	Mediterranean.
Echinocard. **pennatifidum** NORM.	*Amphidotus gibbosus* **(Barrett).**	Northumberland; Straits of Fla.
	LESKIADAE GRAY.	
Paleostoma LOVÉN.		
Paleostoma *mirabilis* LOVÉN.	*Leskia* **mirabilis** GRAY.	China; East India Isls.
	BRISSSINA GRAY.	
Hemiaster DES.		
Hemiaster australis A. AG.	**Tripylus australis** PHIL.	Patagonia.
Hemiaster cavernosus A. AG.	**Tripylus cavernosus** PHIL.	Patagonia; Chili.
Tripylus PHIL.		
Tripylus excavatus PHIL.	**Tripylus excavatus** PHIL.	Patagonia.
Rhynobrissus A. AGASS.		
Rhynobris. pyramidalis A. AG.	**Rhynobrissus pyramidalis** A. AG.	China.
Brissopsis AGASS.		
Brissopsis luzonica A. AG.	**Kleinia luzonica** GRAY.	Luzon; Siam; New Caledonia.
Brissopsis lyrifera AGASS.	*Brissus* **lyrifer** FORBES.	Norway; Mediter'an; Florida.
Agassizia VAL.		
Agassizia **excentrica** A. AG.	*Agassizia* **excentrica** A. AG.	Florida Gulf Stream.
Agassizia scrobiculata VAL.	**Agassizia scrobiculata** VAL.	Panama; Gulf of California.
Brissus KL.		
Brissus carinatus GRAY.	*Spatangus* **carinatus** LAMK.	Society Isls.; Sandwich Isls.; East Indies; Mauritius; Philippine Isls.

NAME ADOPTED.	ORIGINAL NAME.	PRINCIPAL LOCALITIES.
Brissus **obesus** VERRILL.	*Brissus* **obesus** VERRILL.	Panama; Gulf of California.
Brissus unicolor KL.	**Brissus unicolor** KL.	West India Isls.; Cape Verde Isls.; Mediterranean.
Metalia GRAY.		
Metalia africana A. AG.	*Plagionotus* **africanus** VERRILL.	Sherboro Isls.
Metalia maculosa A. AG.	*Echinus* **maculosus** GMEL.	Samoa; Sandwich Isls.; Austr'a; Mauritius; Panama.
Metalia pectoralis A. AG.	*Echinus* **grandis** GMEL.	W. India Isls.; Florida.
Metalia *sternalis* GRAY.	*Spatangus* **sternalis** LAMK.	Sandwich Isls.; Society Isls.; E. India Isls.; Philippine Isls.; Australia; N. Caledonia; Red Sea.
Meoma GRAY.		
Meoma grandis GRAY.	**Meoma grandis** GRAY.	Acapulco; Gulf of California.
Meoma ventricosa LÜTK.	*Spatangus* **ventricosus** LAMK.	W. India Isls.
Linthia MER.		
Linthia australis A. AG.	*Desoria* **australis** GRAY.	Tasmania.
Faorina GRAY.		
Faorina chinensis GRAY.	**Faorina chinensis** GRAY.	China.
Schizaster AGASS.		
Schizaster canaliferus AGASS.	*Echinus* **lacunosus** LIN.	Mediterranean.
Schizaster fragilis AGASS.	*Brissus* **fragilis** DÜB. O. KOR.	Norway; Gulf St. Lawrence; Straits of Florida.
Schizaster **gibberulus** AGASS.	*Schizaster* **gibberulus** AGASS.	Red Sea.
Schizaster Philippii A. AG.	*Tripylus* **Philippii** GRAY.	Patagonia.
Schizaster **ventricosus** GRAY.	*Schizaster* **ventricosus** GRAY.	Feejee Isls.; Philippines; Siam.
Moira A. AGASS.		
Moira *atropos* A. AG.	*Spatangus* **atropos** LAMK.	West Indies; N. & S. Carolina.
Moira *clotho* A. AG.	*Moera* **clotho** MICH.	Gulf of California.
Moira *stygia* A. AG.	*Moera* **stygia** LÜTK.	? Red Sea; Zanzibar. ?

LITTORAL DISTRICTS.

North Pacific (*Pl. B*) and Boreal American Districts (*Pl. A*).

The North Pacific District extends from the Sea of Okhotchk to the Gulf of Georgia, and some of its species even to San Diego. Echinarachius excentricus is found on the American and Asiatic sides of the Pacific, and in the same localities as the North Circumpolar species (*Pl. B*), S. Dröbachiensis.

E. excentricus extends to San Diego, and as far as the Gulf of Georgia is found associated with E. parma, an eminently boreal American (*Pl. A*) species, which however goes far south on the Asiatic side of the Pacific, even to the East India Islands, if we can credit the localities, across the whole of the Japanese and Chinese Districts, and is besides eminently characteristic of the northeastern coast of North America associated with the North Circumpolar species S. Dröbachiensis.

Californian, Panamic, and West South American Districts.

The true Californian (*Pl. B*) fauna, extending from the Santa Barbara Channel Islands to the Gulf of Georgia, lapping the North Pacific and the Circumpolar species, is poor in species, Strongylocentrotus franciscanus and S. purpuratus being thus far the only species known on that extensive stretch of coast strictly peculiar to it. The southern boundary of this fauna merges into the northern extremity of a more varied coast, the Panamic (*Pl. B*), extending from the northern part of Peru to the Santa Barbara Channel, though many of the species have thus far not been traced beyond Cape St. Lucas. Like the Japanese and Chinese fauna, it is made up of generic elements from the adjoining districts, the Indo-Pacific, Peruvian, Panamic, East Indian, Australian, West Indian, all being represented, the former by the presence of such species as Astropyga pulvinata, Toxopneustes pileolus, Lovenia cordiformis, and Metalia maculosa; the Peruvian by the presence of Agassizia, and the species of Arbacia; the strictly Panamic species being for the greater part representatives of the West Indian types; the East Indian having in common a species of Echinanthus, and the Australian the genus Centrostephanus. The (Peruvian) West South American (*Pl. A*) fauna extending from the northernmost part of Ecuador, lapping the Panamic District, extends to the southernmost limit of Chili, two of the species even ex-

tending to Cape Horn and the Straits of Magellan. This district probably includes the Galapagos, which, as far as is accurately known, have about an equal number of Peruvian and Panamic species. Many of the species generally credited to the Galapagos Islands are not known positively to live there. The Peruvian District is remarkable for the great development the Arbaciadae take, the other species being representatives of genera found in the West Indian District, one of the species extending to Australia, and, as I am informed by Dr. Semper (if there is no error in the locality), two of the species extend to the southern extremity of the Philippine Islands.

Patagonian District (*Pl. A*).

As far as known, the species of Echini of the southern extremity of South America are, with few exceptions, peculiar to it. We find three or four Peruvian species extending through the Straits of Magellan, and a few species extending from the mouth of the La Plata on the Atlantic, around the Horn to the coast of Chili, so that, to judge from positive evidence, the extremity of South America forms a district lapping on the Pacific side the Peruvian District (*Pl. A*), and extending on the Atlantic side to the southern extremity of the Tropical Atlantic District (*Pl. A*), of which some of the species reach the southern limit of Brazil, the coast gradually becoming poorer and poorer in species as we go south from the West India Islands, while towards the southern extremity of the continent a remarkable fauna occurs, resembling to a certain extent the combination of species found on the West Coast of Norway, in the North Atlantic District (*Pl. B*): —

Echinus margaritaceus,	Echinus norvegicus,
Echinus magellanicus,	Echinus miliaris,
Goniocidaris canaliculata,	Dorocidaris papillata,
Strongylocentrotus albus,	Strongylocentrotus Dröbachiensis,
Hemiaster australis,	Brissopsis lyrifera,
Schizaster Philippii,	Schizaster fragilis.

Goniocidaris canaliculata appears, if the localities are correct, to have a most extensive geographical distribution, being found at the Sandwich and Navigator Islands, Natal and Falkland Islands, and with Echinocardium australe, which has a somewhat similar range along the southern extremities of all the southern continents, and extending even north of the equator to Japan, form the characteristic species of the great Southern Circumpolar Belt (*Pl. B*).

TROPICAL ATLANTIC DISTRICT (*Pl. A*).

It would be highly interesting to have sufficient data on the bathymetrical range of the species inhabiting the Atlantic to arrive, by a careful comparison of the species found on both sides, at some definite conclusion regarding the influence which depth and temperature have upon the distribution of species. Unfortunately, we can make but very limited comparisons. In spite of the zealous investigations of the elder and younger Sars on the coast of Norway, the Dredging Reports of McAndrew and Barrett and of Normann, and lastly the data furnished by the Porcupine Expedition from the European coasts, we have on our own coasts such a limited range for comparison that any conclusions can be but hints for future use. The identity of several species of the Echini from Florida and the coast of Norway confirmed in a remarkable manner the suggestion first made by Lovén of the possibility of finding in the warmer seas, at great depths, arctic species, the most striking confirmation being the existence of Rhizocrinus at great depths off Florida, off the Azores, on the coast of Portugal, and off Norway. Yet when we come to make a more detailed comparison of the species found on both sides of the Atlantic, we find some of them having such an extraordinary range in depth that, on either side, the extremes were far beyond the effect of any influence, due either to pressure or to temperature. Such were, for instance, Echinocyamus pusillus, Echinocardium cordatum and ovatum; while Brissopsis lyrifera, Dorocidaris papillata, Echinus norvegicus, Asthenosoma hystrix, Pourtalesia, Homolampas, and Schizaster fragilis occur only at such depth in the Straits of Florida as show that temperature and not depth is the main agent in the distribution of the species of Echini over the bottom of the Atlantic. The temperature being dependent upon the action of the sun only to moderate depth, it follows that we reach comparatively soon a depth below which the temperature is comparatively uniform, near the zero point; this uniform tempera 'e probably extending over the greater part of the bottom of the ocean, at depths varying with the latitude. The cold bottom connecting opposite shores in the North Atlantic is probably inhabited only by more or less arctic species, having an extraordinary wide geogra hical range, and corresponding to the arctic character of the fauna and flora of mountain chains and high summits. The only difference between the land and sea being that the ranges of variations of temperature are so small, we cannot

expect to find as great a number of different belts of organized beings as we find on land as we rise in altitude or in latitude. The tabulation of the range of the species thus far found in Florida shows a very wide range in (height) depth, in a comparatively narrow belt of variation of temperature. The species which characterize a local fauna are very limited in depth, while, as a general thing, they have a wide geographical distribution, as will be seen by an examination of the species which eminently characterize the littoral fauna of the West Indies or of the West Coast of Europe, which very soon merge (after two or three intermediate belts) into the deep-water (cold area) fauna of the North Atlantic. The species characteristic of the deep waters of Florida, thus far not found extending to the other side of the Atlantic, are Coelopleurus floridanus, Salenia varispina, Podocidaris sculpta, Trigonocidaris albida, Echinus gracilis, Echinolampas depressa, and Agassizia excentrica. Of the truly littoral species of the Tropical Atlantic District, some of them range from North Carolina, and even New Jersey and Long Island Sound, to the southern extremity of Brazil; a greater number extend from South Carolina to Brazil; a still greater number from Florida to Brazil; while from Florida to the northern part of Brazil we find the strictly West Indian fauna (Tropical Atlantic District) sending out its feelers to the Mediterranean, to the Platte River, to the Bermudas, and to the West African Coast, while some of the deep-water (cold area) species are found in the Gulf of St. Lawrence, the Azores, Shetland Islands, Mediterranean, and West Coast of Norway. Two species, Encope Michelini and Moira atropos, seem to be specially characteristic of the mainland, and thus far extend but a short distance south from Mexico, and do not reach farther north, the one than the Florida Keys, the other than North Carolina; they are on that part of the coast always accompanied by Arbacia punctulata, which thus far has not been found in the West Indies, except on the coast of Cuba and in the Straits of Florida.

The American North Atlantic Coast from New Jersey to Hudson's Bay is inhabited by species belonging in part to the North Atlantic District (*Pl. B*) and the Boreal American (*Pl. A*), and in part to the Tropical Atlantic District (*Pl. A*). One of the species, Echinarachnius parma, is found not only on the Atlantic side of America, but extends from the Straits of Behring along the Aleutian Islands and on the Pacific Coast as far south as the East India Islands. Of the Tropical Atlantic species, Arbacia punctulata extends to the southern extremity of Cape Cod; this is also the limit of Mel-

lita testudinata and of Toxopneustes variegatus.* Of the northern species, the southern limit of Echinarachnius parma is the coast of New Jersey, while Strongylocentrotus Dröbachiensis, the Circumpolar species, is sometimes found as far south as Cape Florida. Of the strictly North Atlantic species, Echinocyamus pusillus does not seem to extend farther west than Iceland, and has thus far not been found on the eastern coast of the United States except in Florida; Brissopsis lyrifera extends as far as Greenland; and Schizaster fragilis as far as the Gulf of St. Lawrence. Of the European Atlantic species, Echinus sphaera extends westward to Iceland.

North Atlantic District (*Pl. B*).

On the European side of the Atlantic the Circumpolar species, Strongylocentrotus Dröbachiensis, does not reach as far south as on the American side, being rarely found south of the English Channel. The range of some of the species — Cidaris papillata, Spatangus purpureus, Echinus acutus, elegans, norvegicus, Echinocyamus pusillus, Echinocardium cordatum, Brissopsis lyrifera — is quite extensive, overlapping as they do the Circumpolar species on the West Coast of Norway, as far north as the Lofoten Islands (in deep water), and even up to North Cape, and stretching thence along the Atlantic shores of Europe, throughout the whole range of the Mediterranean and the Adriatic; all these species, except Spatangus purpureus, E. acutus, and E. elegans, extend across the Atlantic to the deeper waters of Florida and the West India Islands (Guadaloupe), in conjunction with Asthenosoma hystrix, Pourtalesia miranda, Echinocardium pennatifidum, ovatum, and Schizaster fragilis, which as far as known do not extend into the Mediterranean or Adriatic. The strictly European Atlantic species are Echinus sphaera, Echinus miliaris, Spatangus Raschi; they extend along the Atlantic coast, one of the species as far as the Azores, up to the British Islands and Norway, but they are not found in the Mediterranean.

Sphaerechinus granularis, a strictly Mediterranean species, extends north as far as the West Coast of France, and south to the Cape Verde Islands, and westward to the Azores. The same range is also occupied by Strongylocentrotus lividus and Arbacia pustulosa, but they both extend to the other side of the Atlantic, and are found in Brazil associated with the West Indian species.

* Teste Verrill.

Lusitanian District (*Pl. B*).

Leaving the North Atlantic District, we come to the strictly Mediterranean species, consisting of Centrostephanus longispinus, Echinus microtuberculatus, Sphaerechinus granularis, Echinus melo, Echinocardium mediterraneum, and Schizaster canaliferus, overlapping to the north, as far as the Portuguese Coast, and even, for some species, as far as the English Channel, the North Atlantic European fauna, stretching westward as far as the Azores, and to the south as the Cape Verde Islands. Many of the species of the Lusitanian District occur at the Cape Verde Islands with strictly tropical African species, and a few of the West Indian species, extending to the Atlantic Coast of West Africa, and combining with the North Atlantic species found at the Azores, in the Mediterranean, and the Atlantic Coast of West Africa, give to the Lusitanian District, north and south of the Straits of Gibraltar, an extremely mixed character.

The West Indian species are Cidaris tribuloides (Diadema setosum cosmopolitan), Echinometra subangularis, Clypeaster subdepressus. Strongylocentrotus lividus and Arbacia pustulosa belong also to the Mediterranean species, but extend farther north and south than the purely Mediterranean species, and also reach across to Brazil.

The North Atlantic and West European species which extend into this district have already been enumerated.

West African District (*Pl. A*).

Of the Tropical Atlantic African District we know as yet too little to say anything very definite of its range. The existence of two species of Rotula and an Echinolampas, combined with Mediterranean species, as well as West Indian species to the North, is all we know, while the southern limit of this district is as yet entirely undefined, and the coast between the equator and the Cape of Good Hope is completely *terra incognita*. The only thing we know of that district is the presence of Echinometra subangularis at St. Helena and Ascension, but these islands are not sufficiently close to the mainland to give us any clew to the character of the Echini found there.

South Circumpolar District (*Pl. B*).

The southern extremity of Africa is characterized by a very small number of species, the northwestern limit of which is entirely unknown, while the

northeastern limit is soon reached at Natal, the species which characterize the great Indo-Pacific Belt and the Indian District extending as far south as that.

Echinus subangulosus and Echinocardium australe, two of the characteristic species of the district, extend to a great distance, in one case as far as the Nikobar Islands, while Echinocardium australe is, with the exception of the southern extremity of South America, found in the great Antarctic Belt, extending from New Zealand to the Cape of Good Hope, and even passing the equator and extending to Japan, in a similar manner to the extension of Echinocardium cordatum from Norway to Bahia. Echinometra lucunter extends on the eastern coast of Africa very far south, while Diadema setosum, a cosmopolitan species, unites the West African and the Indo-Pacific Districts.

Another species is also found there, which is an antarctic type, Goniocidaris canaliculata; this thus far is the only southern Circumpolar species found, and, like E. australe, extends far north, being found at Zanzibar, Sandwich Islands, and Navigator Islands, if the localities are to be trusted.

Indo-Pacific District (*Pl. A*).

In the great Indo-Pacific Belt the range of the species is very extensive. It is characterized as a distinct belt, not only by its Echinoderms, but also by its other Radiates, Mollusca, and Articulates. Better explored, as far as its littoral fauna is concerned, than the corresponding parts of the Atlantic Ocean, this belt extends on both sides of the equator in the Pacific, reaching from the Sandwich Islands to the East Coast of Africa, comprising the Low Archipelago, the Feejee and Navigator Islands, the north part of New Zealand, New Caledonia, New Guinea, the north shore of Australia, the whole of the East Indian Archipelago, the Bay of Bengal, the Arabian Sea, the Red Sea, and the East Coast of Africa as far as Natal, including the Seychelles, Mascerene Islands, and Madagascar, and extending north as far as the Philippines, the Bonin Islands, and the southern extremity of Japan. This great Indo-Pacific Belt encroaches upon the Australian District in New Zealand, and the western and eastern coast of Australia, upon the Chinese and Japanese District, and touches the west coast of Central America in the Panamic District, while the Indo-African District, as well as the East Indian and Pacific Districts, are both contained within the limits of this great belt.

The Indo-Pacific species having the most extensive range are: —

Cidaris metularia,
Phyllacanthus dubia,
Phyllacanthus verticillata,
Diadema setosum,
Echinothrix turcarum,
Echinothrix calamaris,
Echinothrix Desorii,
Heterocentrotus mammillatus,
Colobocentrotus atratus,
Echinometra lucunter,
Echinometra oblonga,
Parasalenia gratiosa,
Echinostrephus molare,
Hipponoë variegata,
Toxopneustes pileolus,
Clypeaster scutiformis,
Laganum depressum,
Echinonëus cyclostomus,
Maretia planulata,
Brissus carinatus,
Metalia sternalis,
Metalia maculosa.

There is a set of species which range as far in longitude, but do not extend as far north in latitude, having thus far not yet been found extending to any considerable degree north of the equator, and being absent in the Sandwich Islands and the Bonin Islands, though they are found as far east as the Low Islands in the South Pacific, and have also the same general southern limits as the preceding species. They are: —

Phyllacanthus baculosa,
Phyllacanthus imperialis,
Stomopneustes variolaris,
Heterocentrotus trigonarius,
Salmacis Dussumieri,
Fibularia volva,
Clypeaster humilis,
Peronella rostrata,
Nucleolites recens.

Indo-African District (*Pl. A*).

The species which are eminently characteristic of the East Coast of Africa and of the Indo-African District (*Pl. A*) are few; they extend as far as the West Coast of Australia, to the East Indian Archipelago, and even to the southern part of Japan. These are Echinodiscus auritus, E. laevis and biforis, Echinolampas oviformis, Salmacis sulcata and bicolor. With the exception of Schizaster gibberulus, Moira stygia, and Mellita erythrea, the Red Sea is inhabited by the species of the Indian Ocean and of the Indo-Pacific Belt.

Metalia maculosa, Toxopneustes pileolus, and Echinanthus testudinarius extend as far as the West Coast of Central America.

East Indian District (*Pl. B*).

The species belonging strictly to this district, some of which extend as far south and east as the Feejee Islands and New Caledonia, westward to the Persian Gulf, and northward to the southern coast of Japan, are: —

Phyllacanthus annulifera,
Temnopleurus toreumaticus,
Temnopleurus Reynaudi,
Microcyphus maculatus,
Pseudoboletia indiana,
Salmacis rarispina,
Peronella Lesueuri,
Arachnoides placenta,
Nucleolites epigonus,
Anochanus sinensis,
Brissopsis luzonica,
Paleostoma mirabilis,
Faorina chinensis,
Schizaster ventricosus.

Of these species, many lap over the northern limits of the Australian District, extend into the Indo-Pacific District, ranging along the Chinese and Japanese coasts, and encroach extensively upon the Indo-African District; they have been enumerated already.

Pacific District (*Pl. A*).

The strictly Pacific (*Pl. A*) species which do not extend to the westward of the East India Archipelago, and but little north or south of the equator, but many reach eastward as far as the Paumotu Islands, are:—

Phyllacanthus gigantea,
Colobocentrotus Mertensii,
Strongylocentrotus nudus,
Pseudoboletia granulata,
Toxopneustes maculatus,
Mespilia globulus,
Fibularia australis,
Laganum Bonani,
Lovenia subcarinata.

Japanese District (*Pl. B*).

The Japano-Chinese District is remarkable for the large number of species of Strongylocentrotus which take there a great development, some of the species of the genus extending far south along the eastern coast of Australia. True species of Echinus also inhabit the coast, while the association of the species of the District with such Indo-Pacific species as Hipponoë variegata, Echinometra lucunter, Toxopneustes pileolus, Laganum depressum, Maretia planulata, and Echinodiscus laevis, almost conceals the small number of species which characterize this peculiar region. There are, in addition to the species of Strongylocentrotus and of Echinus, Temnopleurus Hardwickii, Phymosoma crenulare, Asthenosoma varium, Astriclypeus Manni, Echinarachnius mirabilis, and Lovenia subcarinata, several of the species found on the East Coast of Africa having their easternmost range on the southern part of the coast of China. Several of the species extend to the Sandwich Islands.

AUSTRALIAN DISTRICT (*Pl. B*).

By far the most typical of all the districts is the Australian, so peculiar that we might be tempted to consider the fauna of Echini as belonging to a different period, were they not contemporaries of some of the species of the Indo-Pacific, East Indian, Japanese, and of the Indo-African Districts, from all of which there are species extending far into the Australian District. This region includes also the New Zealand Islands; they have one or two species thus far limited to the northern islands, which have not yet been found on the Australian coast, — Laganum rostratum and Evechinus chloroticus.

The characteristic feature of the Australian District is the existence of so many species of Amblypneustes and Holopneustes, genera remarkably limited in their geographical distribution. The typical species are: —

Goniocidaris geranioides,
Goniocidaris tubaria,
Stephanocidaris bispinosa,
Centrostephanus Rodgersii,
Salmacis globator,
Holopneustes porosissimus,
Holopneustes inflatus,
Holopneustes purpurescens,
Amblypneustes pallidus,
Amblypneustes griseus,
Amblypneustes ovum,
Amblypneustes formosus,
Eupatagus Valenciennesii,
Breynia Australasiae,
Linthia australis.

Holopneustes and the succeeding genera were formerly represented in the Nummulitic Period of India, and the Tertiaries of Europe; they have, however, totally disappeared from the European seas.

NORTH CIRCUMPOLAR DISTRICT (*Pl. A*).

This district is characterized by a single species only, — S. Dröbachiensis. It extends far into the North Atlantic District, and is associated on the American shores with the Boreal American and the North Pacific species, lapping part of the Japanese and Californian Districts, and extending to the Lusitanian District on the European shores.

LITTORAL LISTS.

The accompanying Lists will show how far the Geographical Districts which have been recognized are natural. The lists are not culled to show the characteristic species of each district; on the contrary, all the species occurring within a given range of coast are included; and as the range of each species in the district is always given, it will be an easy matter, by a comparison of the map and of the lists, to see how far each species contributes to the districts recognized.

OKHOTSK SEA TO GULF OF GEORGIA.

Strongylocentrotus Dröbachiensis A Agass. Okhotsk Sea; Gulf of Georgia.
Strongylocentrotus intermedius A. Agass. Seghalion.
Echinarachnius excentricus Val. Kamtchatka; San Diego.
Echinarachnius parma Gray. Kamtchatka; Aleutian Islands.

GULF OF GEORGIA TO SOUTHERN PERU.

Cidaris **Thouarsii** Val. Peru; Cape St. Lucas.
Diadema **mexicanum** A. Agass. Panama; Cape St. Lucas.
Astropyga pulvinata Agass. Panama; Gulf of California.
Centrostephanus coronatus A. Agass. Cape St. Lucas.
Arbacia nigra A. Agass. Peru.
Arbacia spatuligera A. Agass. Peru.
Arbacia *stellata* Gray. Peru; Santa Barbara.
Colobocentrotus *atratus* Br. Peru.?
Echinometra **Van Brunti** A. Agass. Peru; Cape St. Lucas.
Strongylocentrotus Dröbachiensis A. Agass. Gulf of Georgia.
Strongylocentrotus franciscanus A. Agass. San Diego; Gulf of Georgia.
Strongylocentrotus eurythrogrammus A. Agass. Galapagos.
Strongylocentrotus mexicanus A. Agass. Panama; Gulf of California.
Strongylocentrotus purpuratus A. Agass. San Francisco; Gulf of Georgia.
Strongylocentrotus gibbosus A. Agass. Peru; Galapagos.
Pleurechinus *bothryoides* Agass. Galapagos.
Toxopneustes semituberculatus Agass. Panama; Galapagos; Cape St. Lucas.
Toxopneustes *pileolus* Agass. Panama; Gulf of California.
Hipponoë depressa A. Agass. Panama; Gulf of California.
Amblypneustes **formosus** Val. Galapagos.?
Echinanthus **testudinarius** Gray. Gulf of California.
Clypeaster rotundus A. Agass. Panama; San Diego.
Echinarachnius excentricus Val. San Diego; Gulf of Georgia.

Echinarachnius parma Gray. Gulf of Georgia.
Mellita **longifissa** Mich. Peru; Gulf of California.
Mellita **pacifica** Verrill. Peru; Panama.
Mellita Stokesii A. Agass. Peru; Panama; Galapagos.
Encope **micropora** Agass. Panama; Cape St. Lucas; Galapagos.
Encope grandis Agass. Panama; Gulf of California.
Encope **californica** Verrill. Gulf of California.
Rhynchopygus pacificus A. Agass. Panama; Cape St. Lucas.
Lovenia **cordiformis** Lütk. Peru; Cape St. Lucas.
Agassizia scrobiculata Val. Peru; Cape St. Lucas.
Brissus **obesus** Verrill. Panama; Gulf of California.
Meoma grandis Gray. Acupulco; Gulf of California.
Metalia maculosa A. Agass. Panama; Gulf of California.
Moira *clotho* A. Agass. Gulf of California.

NORTHERN CHILI TO RIO LA PLATA.

Goniocidaris canaliculata A. Agass. Falkland Islands; Straits of Magellan.
Arbacia nigra A. Agass. Cape Horn; Chili.
Arbacia spatuligera A. Agass. Chili.
Arbacia *Dufresnii* Gray. Patagonia; Chili.
Colobocentrotus *atratus* Br. Chili.
Strongylocentrotus albus A. Agass. Straits of Magellan; Chili.
Strongylocentrotus gibbosus A. Agass. Straits of Magellan; Chili.
Echinus **margaritaceus** Lamk. Straits of Magellan; Chili.
Echinus **magellanicus** Phil. Straits of Magellan; Chili.
Hemiaster australis A. Agass. East Coast of Patagonia.
Hemiaster cavernosus A. Agass. Patagonia; Chili.
Tripylus excavatus Phil. Patagonia; Chili.
Schizaster Philippii A. Agass. La Plata; Chili.

SOUTHERN BRAZIL TO EASTERN VIRGINIA.

Cidaris tribuloides Bl. South Carolina; West Indies; Rio Janeiro.
Dorocidaris *papillata* A. Agass. Florida Gulf Stream; Guadeloupe.
Salenia varispina A. Agass Florida Gulf Stream.
Diadema setosum Gray. South Florida; Surinam; Bermudas; West Indies.
Asthenosoma hystrix A. Agass. Florida Gulf Stream.
Arbacia *punctulata* Gray. North Carolina; Florida Gulf Stream.
Arbacia *pustulosa* Gray. St. Thomas; Rio Janeiro.
Coelopleurus **floridanus** A. Agass. Florida Gulf Stream.
Podocidaris sculpta A. Agass. Florida Gulf Stream.
Echinometra subangularis Desml. South Carolina; Bermudas; Rio Janeiro; West Indies.
Echinometra **viridis** A. Agass. Florida Gulf Stream; Hayti; West Indies.
Strongylocentrotus Dröbachiensis A. Agass. South Carolina.
Strongylocentrotus *lividus* Br. Bahia; Rio Janeiro.
Temnechinus maculatus A. Agass. Florida Gulf Stream.
Trigonocidaris albida A. Agass. Florida Gulf Stream.
Hemipedina cubensis A. Agass. Florida Gulf Stream.
Echinus **gracilis** A. Agass. Florida Keys; St. Thomas; West Indies.
Echinus **norvegicus** Düb. o. Kor. Florida Gulf Stream.
Toxopneustes variegatus A. Agass. North Carolina; Bermudas; West Indies.
Hipponoë esculenta A. Agass. South Florida; Bermudas; Surinam; West Indies.
Echinocyamus pusillus Gray. Florida Gulf Stream.
Echinanthus rosaceus Gray. South Carolina; Hayti.
Clypeaster subdepressus Agass. South Carolina; Brazil.
Mellita testudinata Klein. East Virginia; Rio Janeiro; West Indies.

Mellita sexforis A. Agass. South Carolina; Bermudas; Mexico; West Indies.
Encope emarginata Agass. South Carolina; West Indies; Rio Janeiro.
Encope **Michelini** Agass. Alabama; West Florida; Honduras; Yucatan.
Echinonëus semilunaris Lamk. Bermudas; Florida Keys; West Indies.
Echinolampas **depressa** Gray. Florida Gulf Stream.
Neolampas rostellata A. Agass. Florida Gulf Stream.
Rhynchopygus caribaearum Lütk. Florida Gulf Stream; West Indies.
Pourtalesia miranda A. Agass. Florida Gulf Stream.
Homolampas *fragilis* A. Agass. Florida Gulf Stream.
Echinocardium flavescens A. Agass. South Carolina; Bahia.
Echinocardium cordatum Gray. North Carolina; Florida; Bahia.
Echinocardium **pennatifidum** Norm. Florida Gulf Stream.
Agassizia **excentrica** A. Agass. Florida Gulf Stream.
Brissopsis lyrifera Agass. Florida Gulf Stream.
Brissus unicolor Kl. South Florida; West Indies; Bermudas.
Meoma ventricosa Lütk. Florida; West Indies; Honduras.
Metalia pectoralis A. Agass. West Florida; West Indies; Bahia.
Schizaster fragilis Agass. Florida Gulf Stream.
Moira *atropos* A. Agass. North Carolina; Florida; West Indies; Texas.

NEW JERSEY TO ICELAND.

Arbacia *punctulata* Gray. Cape Cod; Long Island Sound.
Strongylocentrotus Dröbachiensis A. Agass. Iceland; New Jersey.
Toxopneustes variegatus A. Agass. New Jersey.
Echinus esculentus Lin. Iceland.
Echinocyamus pusillus Gray. Iceland.
Echinarachnius parma Gray. Labrador; New Jersey.
Mellita testudinata Klein. New Jersey.
Brissopsis lyrifera Agass. Greenland.
Schizaster fragilis Agass. Gulf of St. Lawrence.

NORTHERN SHORES OF SIBERIA TO WEST COAST OF FRANCE.

Dorocidaris *papillata* A. Agass. South Ireland; West Coast of Norway.
Porocidaris **purpurata** Thoms. Shetland Islands; Faroe Islands
Asthenosoma hystrix A. Agass. Shetland Islands.
Arbacia *pustulosa* Gray. West Coast of France.
Strongylocentrotus Dröbachiensis A. Agass. British Seas; Spitzbergen; North Coast of Siberia.
Strongylocentrotus *lividus* Br. West Coast of France; British Seas.
Sphaerechinus granularis A. Agass. West Coast of France.
Echinus **miliaris** Müll. English Channel; West Coast of Norway.
Echinus esculentus Lin. English Channel; West Coast of Norway.
Echinus **acutus** Blainv. West Coast of France; Irish Sea; West Coast of Norway.
Echinus **norvegicus** Düb. o. Kor. British Seas; West Coast of Norway.
Echinus elegans Düb. o. Kor. South of Ireland; West Coast of Norway.
Echinocyamus pusillus Gray. British Seas; West Coast of Norway.
Pourtalesia miranda A. Agass. Shetland and Faroe Islands.
Spatangus purpureus Leske. West Coast of France; West Coast of Norway.
Spatangus **Raschi** Lovén. Shetland and Faroe Islands; West Coast of Norway.
Echinocardium cordatum Gray. English Channel; West Coast of Norway.
Echinocardium flavescens A. Agass. English Channel; West Coast of Norway.
Echinocardium **pennatifidum** Norm. Shetland Islands.
Brissopsis lyrifera Agass. South of Ireland; West Coast of Norway.
Schizaster fragilis Agass. Shetland and Faroe Islands; West Coast of Norway.

PORTUGAL TO WEST COAST OF TROPICAL AFRICA.

Cidaris tribuloides Bl. Cape Verde Islands; Liberia.
Dorocidaris *papillata* A. Agass. Adriatic; Mediterranean.
Diadema setosum Gray. Cape Verde Islands; Canary Islands; Sicily.
Centrostephanus *longispinus* Pet. Madeira; Sicily.
Asthenosoma hystrix A. Agass. Portugal.
Arbacia *pustulosa* Gray. Madeira; Azores; Siberia.
Echinometra subangularis Desml. Cape Verde Islands; Azores; Senegal.
Strongylocentrotus *lividus* Br. Canary Islands; Azores; Sicily.
Sphaerechinus granularis A. Agass. Cape Verde Islands; Azores; Sicily.
Temnechinus maculatus A. Agass. Josephine Bank.
Trigonocidaris albida A. Agass. Josephine Bank.
Echinus **microtuberculatus** Bl. Cape Verde Islands; Sicily.
Echinus **melo** Lam. Cape Verde Islands; Sicily.
Echinus **acutus** Bl. Portugal; Sicily.
Echinus elegans Düb. o. Kor. Cape Sagras.
Clypeaster subdepressus Agass. West Coast Tropical Africa.
Echinocyamus pusillus Gray. Madeira Islands; Azores; Sicily.
Rotula Rumphii Kl. Cape Verde Islands; Senegal.
Rotula Augusti Kl. West Africa; Liberia.
Echinolampas **Hellei** Val. Liberia; Senegal.
Homolampas *fragilis* A. Agass. Josephine Bank.
Spatangus purpureus Leske. Mediterranean; Adriatic.
Spatangus **Raschi** Lovén. Azores.
Echinocardium mediterraneum Gray. Mediterranean; Sicily.
Echinocardium cordatum Gray. Mediterranean.
Metalia africana A. Agass. West Coast Tropical Africa.
Brissus unicolor Kl. Cape Verde Islands; Sicily.
Brissopsis lyrifera Agass. Mediterranean; Sicily.
Schizaster canaliferus Agass. Mediterranean; Sicily.

CAPE OF GOOD HOPE TO ARABIAN GULF.

Cidaris metularia Bl. Red Sea; Mauritius; Madagascar; Mozambique.
Phyllacanthus baculosa A. Agass. Red Sea; Mozambique; Mauritius; Cape of Good Hope.
Phyllacanthus *imperialis* Br. Mauritius.
Phyllacanthus dubia Br. Zanzibar; Cape Town.
Phyllacanthus verticillata A. Agass. Mozambique.
Goniocidaris canaliculata A. Agass. Zanzibar; Natal.
Coelopleurus Maillardi A. Agass. Mauritius.
Diadema setosum Gray. Arabian Gulf; Red Sea; Cape of Good Hope; Mauritius.
Echinothrix *Desorii* Pet. Red Sea; Zanzibar; Cape of Good Hope; Mauritius.
Echinothrix *turcarum* Pet. Red Sea; Zanzibar; Madagascar.
Echinothrix calamaris A. Agass. Mauritius.
Astropyga *radiata* Gray. Mauritius; Mozambique.
Heterocentrotus *mammillatus* Br. Red Sea; Seychelles; Mauritius.
Heterocentrotus *trigonarius* Br. Red Sea; Seychelles, Mauritius.
Colobocentrotus *atratus* Br. Seychelles; Mauritius; Zanzibar.
Echinometra lucunter Bl. Arabian Gulf; Red Sea; Zanzibar; Madagascar; Natal.
Echinometra oblonga Bl. Mozambique.
Parasalenia gratiosa A. Agass. Zanzibar.
Stomopneustes *variolaris* Agass. Bourbon; Zanzibar; Natal.
Sphaerechinus **Australiae** A. Agass. Mauritius.
Pseudoboletia indiana A. Agass. Bourbon; Mauritius.
Echinostrephus molare A. Agass. Bourbon; Zanzibar; Natal.
Temnopleureus *toreumaticus* Agass. Persian Gulf.

Microcyphus **maculatus** AGASS. Muscat; Madagascar.
Salmacis bicolor AGASS. Red Sea; Zanzibar; Mauritius.
Salmacis **sulcata** AGASS. Red Sea; Mozambique.
Echinus angulosus A. AGASS. Bourbon; Mozambique; Cape Town.
Toxopneustes *pileolus* AGASS. Bourbon; Seychelles.
Toxopneustes maculatus A. AGASS. Persian Gulf; Mauritius.
Hipponoë variegata A. AGASS. Red Sea; Mauritius; Mozambique.
Amblypneustes **pentagonus** A. AGASS. Mauritius. ?
Fibularia **volva** AGASS. Red Sea.
Clypeaster scutiformis LAMK. Persian Gulf; Mauritius; Zanzibar.
Clypeaster humilis A. AGASS. Red Sea.
Laganum **depressum** LESS. Persian Gulf; Zanzibar; Mauritius; Madagascar.
Peronella rostrata A. AGASS. Zanzibar.
Echinarachnius parma GRAY. Red Sea.
Mellita **erythraea** GRAY. Red Sea. ?
Echinodiscus **auritus** LESKE. Red Sea; Mauritius; Mozambique.
Echinodiscus biforis A. AGASS. Madagascar; Mussel Bay.
Echinodiscus laevis A. AGASS. Red Sea; Mozambique; Mussel Bay.
Echinonëus **cyclostomus** LESKE. Mauritius; Zanzibar; Mozambique.
Echinolampas *oviformis* GRAY. Red Sea; Mauritius; Cape of Good Hope.
Echinobrissus recens D'ORBIG. Madagascar.
Maretia *planulata* GRAY. Bourbon.
Echinocardium **australe** GRAY. Zanzibar; Cape of Good Hope.
Lovenia elongata GRAY. Red Sea; Zanzibar.
Brissus carinatus GRAY. Mauritius; Mozambique.
Metalia *sternalis* GRAY. Red Sea; Zanzibar.
Metalia maculosa A. AGASS. Mauritius.
Schizaster **gibberulus** AGASS. Red Sea.
Moira *stygia* A. AGASS. Red Sea; Zanzibar.

INDIAN OCEAN TO PHILIPPINE ISLANDS.

Cidaris metularia BL. Indian Ocean.
Phyllacanthus verticillata A. AGASS. Flores; Mindoro.
Phyllacanthus annulifera A. AGASS. Philippine Islands.
Phyllacanthus baculosa A. AGASS. Flores; Amboyna.
Phyllacanthus *imperialis* BR. Ceylon; Aru Islands.
Goniocidaris tubaria LÜTK. Indian Ocean; East Indian Islands.
Diadema setosum GRAY. Bombay; Amboyna.
Echinothrix calamaris A. AGASS. Timor; Amboyna.
Echinothrix *turcarum* PET. Timor; Amboyna.
Astropyga *radiata* GRAY. Borneo; Philippine Islands.
Arbacia nigra A. AGASS. (?) Philippine Islands.
Echinometra lucunter BL. Calcutta; Philippine Islands.
Echinometra oblonga BL. Nikobar; Philippine Islands.
Parasalenia gratiosa A. AGASS. New Guinea.
Heterocentrotus *mammillatus* BR. Indian Ocean; Siam; Philippine Islands.
Heterocentrotus *trigonarius* BR. Java.
Colobocentrotus *atratus* BR. Java; Moluccas.
Stomopneustes *variolaris* AGASS. Java; Calcutta.
Strongylocentrotus albus A. AGASS. (?) Philippine Islands.
Echinostrephus molare A. AGASS. Amboyna.
Pseudoboletia indiana A. AGASS. Philippine Islands.
Temnopleurus *toreumaticus* AGASS. Bombay; Philippine Islands.
Temnopleurus **Reynaudi** AGASS. Birmah; Philippine Islands.
Microcyphus **maculatus** AGASS. Moluccas; Philippine Islands.

Salmacis **sulcata** AGASS. Ceylon; Indian Ocean; Philippine Islands.
Salmacis **rarispina** AGASS. Tranquebar; Philippine Islands.
Salmacis bicolor AGASS. Bombay.
Salmacis **Dussumieri** AGASS. Siam; Philippine Islands.
Mespilia *globulus* AGASS. Philippine Islands.
Echinus angulosus A. AGASS. Nikobar and Philippine Islands.
Hipponoë variegata A. AGASS. Bombay; Philippine Islands.
Toxopneustes *pileolus* AGASS. Timor; Philippine Islands.
Fibularia *ovulum* LAMK. East Indian Islands.
Fibularia **volva** AGASS. Philippine Islands.
Clypeaster scutiformis LAMK. Flores; Philippine Islands.
Clypeaster humilis A. AGASS. Ceylon; Philippine Islands.
Laganum **depresum** LESS. Buru; Philippine Islands.
Laganum Bonani KL. Java; Philippine Islands.
Peronella decagonalis A. AGASS. Bengal; Philippine Islands.
Arachnoides placenta AGASS. Singapore; Philippine Islands.
Echinarachnius parma GRAY. Indian Ocean. ?
Echinodiscus **auritus** LESKE. Amboyna; Philippine Islands.
Echinodiscus laevis A. AGASS. Malacca.
Echinodiscus biforis A. AGASS. Java.
Echinonëus **cyclostomus** LESKE. Flores; Philippine Islands.
Echinolampas *oviformis* GRAY. Tranquebar; Moluccas.
Anochanus sinensis GRUBE. East Indian Islands.
Nucleolites **epigonus** MART. Timor.
Maretia *planulata* GRAY. Siam; Philippine Islands.
Lovenia elongata GRAY. Philippine Islands.
Lovenia subcarinata GRAY. Philippine Islands.
Echinocardium **australe** GRAY. East India Islands.
Brissopsis luzonica A. AGASS. Siam; Banca Straits.
Paleostoma *mirabilis* LOVÉN. Singapore.
Faorina chinensis GRAY. East Indian Islands.
Brissus carinatus GRAY. East Indian Islands; Philippine Islands.
Metalia *sternalis* GRAY. Siam; Philippine Islands.
Metalia maculosa A. AGASS. Timor; Philippine Islands.
Schizaster **ventricosus** GRAY. Siam; Philippine Islands.

SOUTHERN CHINA TO NORTHERN JAPAN.

Asthenosoma varium GRUBE. China.
Diadema setosum GRAY. Ousima; Hong Kong.
Echinometra lucunter BL. Japan.
Strongylocentrotus *tuberculatus* BR. China, Yedo.
Strongylocentrotus nudus A. AGASS. Niphon.
Strongylocentrotus depressus A. AGASS. Niphon.
Strongylocentrotus intermedius A. AGASS. Ousima; Hakodadi.
Sphaerechinus pulcherrimus A. AGASS. China; Hakodadi.
Temnopleurus Hardwickii A. AGASS. Nagasaki; Yedo; Hakodadi.
Temnopleurus **Reynaudi** AGASS. China; North China.
Temnopleurus *toreumaticus* AGASS. China; North China.
Salmacis **sulcata** AGASS. China.
Salmacis **Dussumieri** AGASS. China.
Salmacis **rarispina** AGASS. Shanghae.
Microcyphus **maculatus** AGASS. Ousima.
Microcyphus **zigzag** AGASS. Kagosima.
Mespilia *globulus* AGASS. China; Ousima.
Hipponoë variegata A. AGASS. Ousima.

Toxopneustes *pileolus* AGASS. Formosa; Japan.
Phymosoma crenulare A. AGASS. Hakodadi.
Fibularia **australis** DESML. Ousima
Fibularia **volva** AGASS. Formosa.
Clypeaster scutiformis LAMK. Formosa.
Echinanthus **testudinarius** GRAY. Japan; Hakodadi.
Laganum **Putnami** BARN. Formosa; Ousima.
Laganum **depressum** LESS. Hong Kong.
Peronella decagonalis A. AGASS. Hong Kong; Japan.
Echinodiscus laevis A. AGASS. China; Ousima.
Astriclypeus Manni VERRILL. China; Yedo.
Echinarachnius mirabilis A. AGASS. Yedo; Hakodadi.
Spatangus **Lütkeni** A. AGASS. Formosa; Hakodadi.
Lovenia subcarinata GRAY. China; Hakodadi.
Maretia *planulata* GRAY. China.
Maretia **alta** A. AGASS. Kagosima.
Echinocardium **australe** GRAY. China; Japan.
Brissopsis luzonica A. AGASS. Formosa.
Faorina chinensis GRAY. Hong Kong; China; Shanghae.
Paleostoma *mirabilis* LOVÉN. Kong Kong.
Schizaster **ventricosus** GRAY. Hong Kong.

PACIFIC OCEAN.

Cidaris metularia BL. Solomon and Sandwich Islands
Phyllacanthus dubia BR. Bonin Islands; New Caledonia.
Phyllacanthus *imperialis* BR. Tonga.
Phyllacanthus annulifera A. AGASS. South Sea.
Phyllacanthus verticillata A. AGASS. Navigator and Sandwich Islands.
Phyllacanthus gigantea A. AGASS. Sandwich Islands.
Goniocidaris canaliculata A. AGASS. Caroline and Sandwich Islands.
Diadema setosum GRAY. Feejee and Sandwich Islands.
Echinothrix *turcarum* PET. Bonin, Navigator, and Sandwich Islands.
Echinothrix calamaris A. AGASS. Society Islands.
Echinothrix *Desorii* PET. Feejee Islands.
Centrostephanus Rodgersii A. AGASS. New Caledonia.
Heterocentrotus *mammillatus* BR. Feejee Islands; Sandwich Islands.
Heterocentrotus *trigonarius* BR. New Caledonia; Sandwich Islands.
Colobocentrotus *atratus* BR. Sandwich Islands.
Colobocentrotus Mertensii BR. Bonin Islands.
Echinometra lucunter BL. New Caledonia; Loo Choo and Sandwich Islands.
Echinometra oblonga BL. Solomon and Sandwich Islands.
Parasalenia gratiosa A. AGASS. Bonin Islands; New Caledonia; Sandwich Islands.
Stomopneustes *variolaris* AGASS. Navigator Islands.
Strongylocentrotus *tuberculatus* BR. South Sea.
Strongylocentrotus gibbosus A. AGASS. Feejee Islands.
Strongylocentrotus nudus A. AGASS. Sandwich Islands.
Sphaerechinus **Australiae** A. AGASS. South Sea; Feejee Islands.
Pseudoboletia granulata A. AGASS. Sandwich Islands.
Echinostrephus molare A. AGASS. Kingsmills, Society, and Sandwich Islands.
Temnopleurus *toreumaticus* AGASS. New Caledonia.
Microcyphus **maculatus** AGASS. South Pacific; Navigator Islands.
Mespilia *globulus* AGASS. Navigator Islands; Tonga.
Evechinus *chloroticus* VERRILL. Christmas Islands.
Hipponoë variegata A. AGASS. Pelew Islands; Feejee Islands; Sandwich Islands.
Toxopneustes *pileolus* AGASS. Navigator Islands; Feejee Islands.

Toxopneustes maculatus A. AGASS. Feejee Islands; Christmas Island.
Amblypneustes pallidus VAL. Feejee Islands.
Fibularia **australis** DESML. South Sea; Sandwich Islands.
Fibularia **volva** AGASS. Kingsmills Islands.
Clypeaster scutiformis LAMK. Kingsmills and Sandwich Islands.
Clypeaster humilis A. AGASS. New Caledonia.
Echinanthus **testudinarius** GRAY. Sandwich Islands.
Laganum **depressum** LESS. South Pacific; Feejee and Sandwich Islands.
Laganum Bonani KL. Pelew Islands.
Peronella decagonalis A. AGASS. New Caledonia.
Arachnoides placenta AGASS. South Sea; Solomon Islands.
Echinodiscus laevis A. AGASS. New Caledonia.
Echinoneus **cyclostomus** LESKE. Navigator and Sandwich Islands.
Nucleolites **epigonus** MART. Lord Hood's Island.
Maretia *planulata* GRAY. Kingsmills; New Caledonia.
Lovenia subcarinata GRAY. Sandwich Islands.
Faorina chinensis GRAY. Sandwich Islands.
Brissus carinatus GRAY. Pelew, Feejee, and Sandwich Islands.
Metalia maculosa A. AGASS. Kingsmills, Society, and Sandwich Islands.
Brissopsis luzonica A. AGASS. New Caledonia.
Metalia *sternalis* GLAY. South Sea; New Caledonia; Navigator and Sandwich Islands.
Schizaster **ventricosus** GRAY. Pelew and Feejee Islands.

WEST, SOUTH, EAST, AND NORTHEAST AUSTRALIA TO NEW ZEALAND.

Phyllacanthus verticillata A. AGASS. South Sea.
Phyllacanthus annulifera A. AGASS. South Sea.
Phyllacanthus dubia BR. Australia.
Phyllacanthus *imperialis* BR. Australia.
Goniocidaris *geranioides* AGASS. Murray River; West Australia.
Goniocidaris tubaria LÜTK. Bass Straits; Tasmania.
Stephanocidaris bispinosa A. AGASS. Australia.
Centrostephanus Rodgersii A. AGASS. Sidney; Houtman's Abrolhos.
Echinometra lucunter BL. North Australia; Houtman's Abrolhos.
Strongylocentrotus *tuberculatus* BR. Sidney.
Strongylocentrotus **armiger** A. AGASS. Australia.
Strongylocentrotus eurythrogrammus A. AGASS. North Australia; New Zealand; Sidney; Murray Riv.
Sphaerechinus **Australiae** A. AGASS. New Zealand; East Australia; Adelaide.
Microcyphus **maculatus** AGASS. Tasmania; W. Australia.
Microcyphus **zigzag** AGASS. Australia.
Salmacis **rarispina** AGASS. Cape York.
Salmacis **sulcata** AGASS. Port Mackay.
Salmacis **globator** AGASS. Australia.
Holopneustes **porosissimus** AGASS. Australia.
Holopneustes inflatus A. AGASS. East Australia; New Zealand.
Holopneustes purpurescens A. AGASS. Australia; Tasmania; Murray Riv.
Amblypneustes *griseus* AGASS. New Zealand; Sidney; Adelaide.
Amblypneustes ovum AGASS. Sidney; Port Lincoln.
Amblypneustes pallidus AGASS. Port Philip; Adelaide.
Amblypneustes **formosus** VAL. Tasmania; Adelaide.
Evechinus *chloroticus* VERRILL. New Zealand.
Echinus **margaritaceus** LAMK. South Sea; New Zealand.
Echinus angulosus A. AGASS. New Zealand; Adelaide.
Fibularia **australis** DESML. Coral Sea.
Fibularia **volva** AGASS. North Australia.
Echinanthus **testudinarius** GRAY. Australia.

Laganum **depressum** LESS. Australia.
Laganum **Putnami** BARN. Australia.
Laganum Bonani KL. Tasmania; Australia.
Peronella *Peronii* GRAY. Brisbane Water; Tasmania.
Peronella decagonalis A. AGASS. West Australia.
Laganum rostratum A. AGASS. New Zealand.
Echinobrissus recens EDW. New Zealand.
Eupatagus Valenciennesii AGASS. Port Dalrymple; Tasmania.
Lovenia elongata GRAY. Port Dalrymple; West Australia.
Echinocardium **australe** GRAY. New Zealand; West Australia.
Breynia Australasiae GRAY. South Sea; Sidney; West Australia.
Metalia sternalis GRAY. North Australia; Sidney; New Zealand.
Linthia australis A. AGASS. Flinders Islands; Tasmania.

GEOGRAPHICAL DISTRIBUTION OF THE GENERA.

The geographical distribution of the genera, which has formed the basis for the division of the oceans into the four great realms (*Pl. G*) recognized among recent Echini, is given in detail in Plates C, D, E, and F. It has been found impracticable to arrange them on the maps systematically, on account of the color printing and the economy of space. Those genera, therefore, which have a very similar geographical distribution are brought together, or are so limited as not to interfere with the ready understanding of the limits of the other genera represented. It has not been found possible to give always the precise limit of the extension of each genus, but as the exact localities of each species are given with the synonymy, this is not a serious defect, and the range of each genus is sketched out in broad outlines. Genera which have nearly the same range, but differ in some minor points, are represented as identical, — a method, of course, not strictly accurate, but sufficiently so to call up in a broad way the districts to which these genera are limited; as, for example, in *Pl. D* the range of the genera Pseudoboletia, Phyllacanthus, Colobocentrotus, etc., which means simply that the extremes of range are so nearly identical that although the localities from which some of the genera are known to occur are more numerous than others, yet if we intercalate between the extremes, instead of adopting the more accurate method of mapping only what is known, we shall arrive at about the same geographical distribution. In order not to introduce too many colors when the range of a genus is nearly co-extensive with that of two or more genera, the different colors characteristic of the separate genera are given for the genus having the widest range: for instance, in *Pl. D* the range of Echinonëus is made up of its own color in addition to the colors indicating the range of Pseudoboletia, Phyllacanthus, etc.; Salmacis, Echinodiscus, etc., range over a still more limited district, included not only within the limits of the district over which Echinonëus is found, but also within the limits of the range of Pseudoboletia. In the same way in *Pl. C*,

Echinanthus ranges over an area included within the range of Cidaris, Echinometra, etc. And in this same Plate (*C*) the range of Astriclypeus and Faorina, of Arachnoides, Peronella, etc., of Holopneustes, Amblypneustes, etc., is considered sufficiently approximate to be indicated by the same color. In *Pl. E* the range of Hipponoë and Toxopneustes is included within the limits of the range of Brissus, Lovenia in its turn being included within the limits of the range of Hipponoë and Toxopneustes. These examples will suffice to explain the method adopted to show the geographical distribution of genera. Where the localities are in the least doubtful, they have been omitted in the representation of the distribution of the genus on the maps, as in the case of the occurrence of Moira on the Pacific coast of Mexico, and of Mellita and Moira in the Red Sea. Other genera, consisting of but single species of a limited or doubtful range, have also been omitted. They are few, however, and the maps include every genus which is well characterized, the distribution of which can be tolerably accurately ascertained from the range of its species.

PLATE *C*.

Amblypneustes,
Arachnoides,
Astriclypeus,
Astropyga,
Cidaris,
Clypeaster,
Coelopleurus,
Diadema,
Echinanthus,
Echinobrissus,
Echinolampas,
Echinometra,
Echinus,
Eupatagus,
Faorina,
Holopneustes,
Linthia,
Mespilia,
Möira,*
Neolampas,
Nucleolites,
Paleostoma,
Peronella,
Trigonocidaris.

PLATE *D*.

Breynia,
Centrostephanus,
Colobocentrotus,
Dorocidaris,
Echinarachnius,
Echinocyamus,
Echinodiscus,
Echinonëus,
Echinostrephus,
Fibularia,
Heterocentrotus,
Laganum,
Maretia,
Microcyphus,
Parasalenia,
Phyllacanthus,
Pseudoboletia,
Rotula,
Salmacis,
Stomopneustes,
Strongylocentrotus,
Temnopleurus.

PLATE *E*.

Agassizia,
Asthenosoma,
Brissus,
Encope,
Goniocidaris,
Hemiaster,
Hipponoë,
Homolampas,
Lovenia,
Mellita,
Meoma,
Pourtalesia,
Rhynchopygus,
Temnechinus,
Toxopneustes,
Tripylus.

PLATE *F*.

Arbacia,
Brissopsis,
Echinocardium,
Schizaster,
Spatangus.

* Spelled on map Moera.

PART II.

ECHINI

OF THE

EASTERN COAST OF THE UNITED STATES,

TOGETHER WITH A REPORT ON THE DEEP SEA ECHINI COLLECTED
IN THE STRAITS OF FLORIDA, BY L. F. DE POURTALÈS,
ASSISTANT UNITED STATES COAST SURVEY,
IN THE YEARS 1867–1869.

BY

ALEXANDER AGASSIZ.

Published by permission of PROF. B. PEIRCE, *Superintendent U. S. Coast Survey.*

WITH FORTY-TWO PLATES.

NOTE.

With the permission of Professor Peirce, the Superintendent of the Coast Survey, I have been able to incorporate in my Revision of the Echini the Report on the Deep Sea Echini collected by Count Pourtalès in 1867–1869, while in charge of the expeditions made for the exploration of the Gulf Stream by the United States Coast Survey, in the steamers Corwin and Bibb, Acting Master Robert Platt, U. S. N., commanding. As this Report includes nearly all the species found on the eastern coast of the United States, two of the northern species not actually found by Count Pourtalès have been added to the Report, to make it as far as possible a complete picture of the Echini of the Atlantic coast of the United States. This was the more advisable, as, both these species having been very fully examined in all their earlier stages of growth, they were of essential assistance in the study of the small Echini collected by Mr. Pourtalès.

From the large number of small-sized Echini collected by Mr. Pourtalès it became necessary, in order to study them intelligently, to examine the young of as many species as possible, and obtain some criterion by which to determine this collection accurately. The results to which this examination led me formed the basis of the Preliminary Report, published in the Museum Bulletin, in which was given, as far as it could be done without figures, a short *résumé* of the conclusions to which I have been led by the study of these young, leaving for this Report a detailed description, as well as figures, of the changes there mentioned, which these young undergo. Some of the specimens collected by Mr. Pourtalès are so small that they must have absorbed their Pluteus very recently before their capture. This col-

lection, taken in connection with the Museum materials, gave the means of studying the changes due to growth of the following species: —

Cidaris tribuloides.
Dorocidaris papillata.
Diadema setosum.
Echinothrix turcarum.
Arbacia punctulata.
" pustulosa.
Echinometra Van Brunti.
Strongylocentrotus Dröbachiensis.
Echinus acutus.
" melo.
" norvegicus.
" gracilis.
Sphaerechinus granularis.
Microcyphus zigzag.
Temnopleurus Reynaudi.
Temnechinus maculatus.
Trigonocidaris albida.
Toxopneustes variegatus.
" pileolus.
Hipponoë esculenta.
Echinocyamus pusillus.
Echinanthus rosaceus.
Clypeaster subdepressus.
Echinarachnius parma.
Encope emarginata.
Mellita testudinata.
" sexforis.
" longifissa.
Fibularia volva.
Echinolampas depressa.
Echinocardium cordatum.
Brissus unicolor.
Brissopsis lyrifera.
Agassizia excentrica.

I doubt if, without the aid of the information gained by the study of these young Echini, a satisfactory report of this collection could have been made. The changes some species undergo are so great that nothing would have been more natural than to place the two extremes of the series not only in different species, but often in different genera, and even in different families. As a necessary consequence, the study of these young, showing what we may consider differences due only to growth, will lead to the elimination of numerous species and genera, and give us hereafter a much more accurate basis in our limitation of genera species, and the higher subdivisions. I shall always consider myself fortunate to have had the opportunity — thanks to the liberality of the Superintendent of the Coast Survey — of examining this collection, forming the most valuable addition to our knowledge of recent Echinoids since the collections of the same order made by Stimpson in the Pacific.

The changes in the classification of the Echini, hinted at in the Preliminary Report, have been carried out as far as the recent Echini are concerned, and I trust that the materials I have succeeded in accumulating will form a more correct standard than we have had heretofore for the determination of the fossil species. The number of fossil genera has been increased to such an

extent, and they have been based upon features which are here shown to have so little value, that before we can make a satisfactory comparison of the fossil species with those now living, a thorough re-examination of the fossil Echini from our present stand-point is absolutely necessary.

In order not to duplicate the descriptions of the Echini of the eastern coast given in this part (Part II.), I shall simply refer to them in their proper place in the descriptive portion of the Revision, Part III. The characters of the families will be fully discussed there; the genera mentioned are, however, described at length, as their limits are frequently so different from those generally accepted that, unless this were done, some confusion would naturally follow. In order to illustrate the species of the Report as fully as practicable, several of the Plates of the descriptive and anatomical parts have been issued with the present Report, as it was found impossible to draw the line distinctly between the plates belonging to the different parts of the Revision of the Echini.

ECHINI

OF THE

EASTERN COAST OF THE UNITED STATES.

DESMOSTICHA.

Suborder **Desmosticha** HAECKEL, Entwickel. Gesch. 1866. (emend.)

CIDARIDAE.

Family **Cidaridae** MÜLL. Bau der Echin. 1854 (emend.)

GONIOCIDARIDAE.

Subfamily **Goniocidarida** HAECKEL, Entwickel. Gesch.

THE subordinal divisions usually adopted since their introduction by Albin Gras do not seem satisfactory, if tested by our present information. In the first place, the whole classification is based upon the separation of the anus from the abactinal system. From what the embryology of Echini has taught us, the position of the anus has not the physiological importance attributed to it by authors who have so generally received this classification. The unstable position it occupies in the same animal at different stages of growth — at one stage opening next to the mouth, then on the margin, and finally opening in the central part of the apical system in the adult — should make us hesitate to adopt a single anatomical feature as our sole guide. In the first place, the order of Perischoechinidae, a most natural one, is founded upon characters derived from the structure of the interambulacral and ambulacral systems. The other two suborders, regular and irregular, usually recognized, can scarcely be called natural. The suborder of regular Echini is more satisfactory than the other, though, from what I have said in the Preliminary Report of the Galerites with teeth, I should be inclined to add them to the suborder of the regular Echini (Desmosticha), as one of its three primary subdivisions, which, as here limited, are the Cidaridae, the Echinidae proper, and the Galerites. The suborder of "irregular" Echini, after the with-

drawal of the Galerites, still contains the Clypeastroids. From the structure of the ambulacral system, they have some affinity with the Spatangoids; yet the presence of partitions and teeth, combined with petaloid ambulacra, seem to constitute good subordinal characters for the Clypeastroids as contrasted with the Spatangoids proper, which include all the edentate forms, taking in also the edentate genera formerly placed among Galerites, as well as the Cassidulidae, sometimes regarded as independent suborders.

CIDARIS.

Cidaris Klein, 1734. Nat. Disp. Echin.

Test thick, circular, turban-shaped; actinal and abactinal region equally flattened; ambulacra narrow, undulating, having only granular tubercles arranged in vertical rows rarely more than six; poriferous zones narrow, forming a single vertical row of contiguous, disconnected pores. Interambulacra from three to five times as broad as the ambulacra, with but two vertical rows of primary tubercles; these are few in number, rarely going beyond seven in each vertical row in the largest specimens. They are surrounded by large scrobicular circles, either elliptical or circular. Areola more or less sunken beneath the concave miliary zone; granular tubercles occupy the whole of the coronal plates between the scrobicular circle; the primary tubercles are perforated with a smooth base in all recent specimens.

The abactinal system is large, flat; composed more or less of pentagonal genital plates, nearly uniform in size separated by triangular or crescent-shaped ocular plates. The anal system is pentagonal, with larger plates in angles of pentagon between genital plates.

The primary spines are large, stout, cylindrical, club-shaped, more or less fluted, often surpassing the diameter of the test in length, and the granulations assuming only a longitudinal linear arrangement.

The name **Cidaris** dates back to Klein, but he as well as Leske used Cidaris to denote what corresponds to the Echini regulares. The first limitations were made by Lamarck, and his species of Cidarites correspond to the Cidaridae of Müller and Diadematidae of Peters. The genus has been subsequently modified by Gray, Brandt, Agassiz, Desor, Cotteau, and A. Agassiz. For the sake of convenience, we can separate into two categories the species of Cidaris, those with crenulated base and those with a smooth base.

Cidaris tribuloides

! *Cidarites* **tribuloides** Lamk. 1816. An. s. Vert.
! *Cidaris tribuloides* Bl. 1830. Zooph.

Pl. I^{a}.; Pl. II. f. 1–3; Pl. II^{c}. f. 13.

Genital plates somewhat rectangular; ocular large, triangular, with rounded sides; anal system pentagonal; larger plates adjoining genital plates extend little ways towards ocular, so as to separate the genital plates but slightly; whole abactinal system covered with miliary tubercles of nearly uniform size, carrying small, flat, short secondary spines; genital openings placed near outer edge of the plates. Ambulacral zone with one outer row of miliary tubercles separating it from the poriferous zones, and four rows of smaller miliaries,—two well defined, extending between them nearly the whole length of ambulacra, and two exceedingly irregular ones of still smaller tubercles. The two main rows of interambulacral tubercles are separated by a broad median row of miliaries of nearly uniform size, slightly smaller on the median line, the miliaries round the scrobicular circle being but slightly larger. The mamelon is small, with a moderate scrobicular circle. In large specimens there are three small miliary tubercles on each side of the perforated scales of the actinal membrane.

The primary spines are cylindrical, rather slender, sometimes slightly tapering, in younger specimens slightly swollen near the lower extremity; their coloration is light brown, violet tinged, often ringed with white and brown; the granulation is quite close and compact. The secondary spines are broad, flat, yellowish-green, tipped with brown; the ambulacral miliary spines are elongated, of the same color as the secondary ones, while in the interambulacral zone they are gradually reduced to mere papillæ in a large part of the zones.

Lütken has adopted for the common West India species the name of *C.* **metularia** Lam., which he compares carefully with Cidaris tribuloides. It is evident from his descriptions that his C. tribuloides is the *C.* **metularia** Lam.; he says himself that he may not have had the true *C.* **tribuloides** Lam. From a direct comparison of the original specimens of Lamarck of both these species in the Jardin des Plantes, there is no doubt that the *C.* **tribuloides** of Lamarck is the common West India species for which the name of *C.* **annellata** of Gray had been adopted in the Preliminary Report, supposing Gray to have possessed, as far as could be judged from his descriptions, the common littoral species of the Gulf of Mexico. Gray's originals show that this was a mistake. The locality, however, of his *C.* **annellata**

is not correct; it is undoubtedly a Pacific species. The original of Lamarck's *Cidarites* **metularia** is from the Isle de France, there are also in the Jardin des Plantes specimens from the Red Sea; it has an extensive range, occurs as far as the Sandwich Islands, is quite common in the East Indian Archipelago. The *C.* **metularia** LAM. is also identical with the species which I named **Gymnocidaris minor**, in the Museum Bulletin (1863). Not having, at the time, had the opportunity of examining series of different ages, I find that the differences which had been considered as specific are simply different stages of growth.

In this species of Cidaris, as in genus Cidaris usually, the difference between old and young stages is almost entirely limited to the proportionally larger size of the spines (*Pl. II^c. f. 13*) and the more prominent serrations (recalling Salenia). The abactinal system early assumes the character of the adult; in fact, with the exception of the smaller number of coronal and buccal plates, the above differences in the spines are the only important changes undergone in this genus.

Littoral to 116 fathoms.

(CIDARIS.) DOROCIDARIS.

Dorocidaris A. AGASS. 1869. Bull. M. C. Z., I. et al.

This subgenus differs from **Cidaris** proper by its narrow median ambulacra; in interambulacral area, the smaller number of primary tubercles, with a deep sunken scrobicular area, the scrobicular circle formed by close granulation, leaves the median interambulacral space more or less sunken and bare. The abactinal area is large, does not differ essentially from Cidaris. The spines of this subgenus are long, surpassing the diameter of the test, often twice as long as diameter; fluted, or with pointed granulations arranged in longitudinal ridges or forming disconnected lamellæ. Poriferous zone narrow, undulating with disconnected pores.

Dorocidaris papillata

Cidaris **papillata** LESKE, 1778. KLEIN, Add.
! **Dorocidaris** *papillata* A. AG. 1869. Bull. M. C. Z., I.

Pl. I; Pl. II^c. f. 13–15; Pl. I^b.; Pl. II^a. f. 1–13; Pl. II^b. f. 1–5.

I had, in the Preliminary Report, distinguished the specimens from Florida from Cidaris papillata as **Dorocidaris abyssicola**. An examination of a fine series of Cidaris papillata collected on the west coast of Norway by Dr. Sars, in the Shetland Islands, and in sundry localities extending from Cape Wrath,

to Cape Sagras collected by the Porcupine Expedition, and which I owe to Prof. Wyville Thomson, shows such astonishing variation in the proportions of the coronal plates, the length and thickness of the spines, the position and size of the genital openings, the size of the anal system, of the ocular plates, that the differences I had supposed to be specific between C. papillata and D. abyssicola can only be considered as amounting to individual variations. The difficulty of distinguishing the Mediterranean C. hystrix from the northern C. papillata had already suggested their probable identity, and now that we have the fine series of the Porcupine Expedition, we can hardly hesitate to unite as one species Cidaris papillata, hystrix, abyssicola, and affinis (or Stokesii); the latter being the name given to Mediterranean specimens having comparatively shorter and more distinctly serrated spines than is the case in specimens where the fluting of the spines becomes more prominent, accompanied also by more slender papillæ, features which are repeated in the individual variations of specimens of one and the same locality in the fine series of the Porcupine Expedition collections. It is true that the color given by Philippi and Sars of C. affinis as brilliant vermilion is very different from the color of the Florida specimens, which Mr. Pourtalès informs me are when alive more or less straw color, with a tendency to a dull greenish-brown color, quite well developed in some of the specimens; but as color forms such an unimportant feature in the specific characters of Echini, much stress cannot be laid upon this point.

Median interambulacral space sunken, vertical suture of plates distinctly marked, edged by narrow bare space; three to four concentric rows of secondary tubercles, but slightly smaller than those of the scrobicular circle, extend towards median line from scrobicular circle. Scrobicular area sunken, elliptical. Mamelon small, prominent; mammary boss small, indistinct. Broad zone of secondary and miliaries separating the poriferous zone, the secondary tubercles arranged in irregular radiating rows, separated by slightly marked furrows. In the median ambulacral region the two inner vertical rows of secondary tubercles are near the middle and but little smaller than the external rows. Spines long, fluted, scarcely tapering, often equal in length to twice the diameter of the test. From twelve to eighteen longitudinal furrows on spines, frequently forming lamellæ, or simply ridges with interstitial space fully grown up; collar of spine short, milled ring prominent.

Abactinal system sparsely covered with miliaries in central part of plates, leaving edges bare, well marked by a wavy double line of small tubercles.

Anal system pentagonal, with a more or less pointed plate extending between the genital plates to ocular plates, genital plates rectangular with truncated edges, genital opening large, placed one third diameter of plate from outer edge, ocular plates heart-shaped, ocular opening distinct. Ambulacral papillæ long, slender; interambulacral much curved and stouter.

In younger specimens the sutures are not so prominent, the stellar shape of the anal system not so marked.*

There are considerable differences in the external appearance of specimens collected at different points. A lot of specimens dredged off Carysfort Reef, at a depth of sixty fathoms, at first sight presents such striking contrast to the bulk of the specimens, that it was catalogued as a distinct species. Instead of the long smooth spines, perfectly white, which was characteristic of all the specimens (except quite small ones) thus far collected, they have long slender spines, not so stout in proportion to the diameter of test as when ridges are worn out, with very distinct and prominent longitudinal rows of serrations, but the base of the spine and the milled ring have the same character as the other spines. There is, however, round the abactinal system a circle of younger spines, which are not serrated, but are, on the contrary, somewhat stouter than others, short and smooth, having the same structure as the spines of specimens where all are smooth, or nearly so. The specimens with these slender primary spines also have secondary spines round the primary tubercles of much greater fineness. The coronal plates are more numerous in the specimens with finer serrated spines, but not more so than we find in many of the younger specimens, where the spines are smooth. Had it not been for some specimens collected in forty fathoms near Carysfort Reef, I should have considered these differences of sufficient value to be specific; but several fine specimens possessing half-striated, half-

* The measurements are given in millimetres, the abactinal system is measured from the extremity of the genital plate carrying madreporic body to the outer edge of the opposite ocular plate. The actinal system is measured from the median interambulacral line to the opposite median ambulacral space. The length of the anal system and of the spines when given is always the greatest length. The number of coronal plates given is the number of the interambulacral plates carrying the primary tubercles.

Height.	Diameter.	Abact. Syst.	Actin. Syst.	Spine.	No. of Int. Coronal Plates.
24.5	36.76	19.05	9.04	31. 27.	7 to 6
17.7	27.9	13.8	7.5	51. 50.	6 to 5
18.2	13.9	8.1	2.7	12.5	6 to 5
3.7	9.0	6.3	3.0	11.	6 to 5
2.75	3.6	2.6	1.5	3.75	5 to 4

From forty to two hundred and seventy fathoms.

serrated spines, and specimens possessing thicker smooth spines, fine secondary spines seemed to leave no differences of any value. The abactinal system identical in the two forms. These differences in the spines are probably the result of wear, for the young of both the varieties are identical. In one case the serration becomes worn, stimulating the growth of the spines, as is the case also in Heterocentrotus, where broken or bruised spines frequently exceed in size the spines which have grown normally. As far as I have observed, in the genus Cidaris the spines seem to vary but little in one and the same species, excepting those modifications which are due to the very variable size of the spines upon different parts of the test; but they are all after one pattern; the spines round the actinostome being the only ones which, owing to the constant wear, are liable to be worn out of their regular pattern. Such is at least the case in Cidaris tribuloides, metularia; P. imperialis, baculosa, gigantea; Goniocidaris geranioides, S. bispinosa.

The tubercles are not perforated in small specimens, and it is only long after all the specific characters (*Pl. II^c. f. 8*) are well developed, that the perforation appears, showing that too great value ought not to be attached to this character. The function of this perforation will only be satisfactorily settled from an examination of living specimens.

The mode of growth of the buccal plates of the Cidaridae is totally unlike that of all the other Echinidae, with the exception, probably, of Asthenosoma. These plates perform the part of ambulacral and interambulacral plates, and appear near the test at first, forming in full-grown specimens rows made up of more than two plates, as in the Palaechinidae, suggesting that the test of Palaechinidae must have been made up of plates homologous to the buccal plates of Cidaris. The test, of course, would then have been capable of considerable compression and change of outline, as is the case in Astropyga and Asthenosoma. This similarity is very striking in young Cidaridae, where the number of coronal plates is small, and when the young Sea-urchin seems to consist almost entirely of an abactinal and an actinal system, separated by a narrow band of coronal plates. Let this narrow band of coronal plates disappear entirely, and the buccal plates take a correspondingly great development, and we have a Palaechinus made up of small ambulacral and interambulacral plates consisting of several rows, and continuous from the teeth to the abactinal system, similar to that discovered by Meek and Worthen, the whole test surmounted by short spines, articulating

upon a more or less distinct mamelon. The structural features of the buccal membrane of Cidaridae, of the teeth and of the poriferous zone, appear to entitle them to a higher rank than that of a family, in the suborder of Echinoids, intermediate between the Palaechinidae and Echinidae proper.

SALENIDAE.

Subfamily **Salenidae** AGASS. 1838. Mon. Éch. Salénies. (emend.)

SALENIA.

Salenia GRAY, 1825. Ann. Phil.

Small Echini, remarkable for the extraordinary development of the abactinal system, the connection of one (large subanal plate) of the anal plates with the genital plates, the other anal plates very small, the sutures of the abactinal plates more or less pitted, the madreporic body quite indistinct. Interambulacral areas broad, coronal plates few in number, tubercles in ten principal rows, imperforate, distinctly crenulated, median interambulacral occupied by vertical rows of small secondaries, carrying different kinds of spines (papilliform) from those of the primaries, the abactinal part of ambulacra having similar spines. Primary spines large, of various shapes. Poriferous zones narrow, pores arranged in single vertical pairs. Buccal membrane imbricated, but ambulacra not extending through the buccal plates, as in Cidaridae and some Diadematidae.

The structure of the abactinal system in young Echini explains most unexpectedly the homology of the subanal plate of Salenidae, which has been such a puzzle to Echinologists. In the first place, I must reiterate that the position of the anal system within the abactinal system is not one which can be defined geometrically by any axis we can draw, nor does it hold any organic connection with the general structure of Echini; the madreporic body alone, in Echini proper, giving us the key to the position of an axis which is most intimately connected with the structure of the Sea-urchin. The genital plates are not equally developed: in some genera the ocular plates occupy an intermediate position between genital plates of apparently the same size; but in others the posterior genital plates are somewhat less developed, and the ocular plates are thus placed in direct contact with the anal system,

in which case the anal system appears pushed back posteriorly as in Salenia, owing to the original spiral condition of the Sea-urchin, which continues to affect the growth during the whole time of its existence (see figs. of young Cidaris); the abactinal system sometimes shows very plainly the spiral mode of growth by not being perfectly symmetrical, that is, the plates on the two sides of the longitudinal axis are not equal in size; this is particularly the case in some species of Salenia. The structure of the abactinal system of our living species, Salenia varispina, fully corroborates the view taken of the proper homology of the subanal plate of the Salenidae. The analysis of the abactinal system of a living Salenia here described shows that the subanal plate is the homologue of the first-formed anal plate of young Echini (which in many cases remains decidedly larger even in older stages, Salmacis, Temnechinus, Trigonocidaris), and shows that the abactinal system of Salenia is entirely homologous with the abactinal system of the other Echinoids, the original, first-formed plate only retaining a greater preponderance than has been thus far noticed in other genera. Add now to this eccentric position of the anal system the presence of a large plate covering (as in young Echini) nearly the whole of the anal system, and we have then the remainder of the anal system covered by excessively small plates (as in young Echini), lost, of course, in the fossil Salenidae thus far found. This shows that the subanal plates have no special function, are not special plates found in the group of Salenidae alone, but are simply an embryonic feature retained in the adult, — as is the case in other genera, where, instead of one plate, we may have several (Arbacia, etc.), — so that this subanal plate is simply a part of the plates covering the anal system, and has nothing to do in the apical system with the genital and ocular plates; although from its size it appears (as in young Echini) to be a most prominent feature, and to form part of the genital plates in the abactinal system. This so-called subanal plate is readily recognized as such in Temnechinus (see *Pl. VIII. f. 3*), while even in genera in which the existence of the subanal plate has never been claimed (Temnopleurus, Salmacis), we find that in the oldest specimens of some of the species, this first plate, which at first covered the whole anal system, always retains a marked predominance, and can readily be distinguished from the others, subsequently added to cover the increasing size of the anal system.

The remaining part of the anal system was, in the fossil species, undoubtedly covered by small plates, as in the living species; and that this was the probable structure of the anal system is shown by Wright, who has figured

the abactinal system of Acrocidaris, and removed the genus to Salenidae on account of the presence of a subanal plate. This feature, which seemed so characteristic of a small group of Echini, is one which alone has no primary systematic value, so that we must, I think, hereafter consider the Salenidae simply as a subfamily of Cidaridae, as the description of the species dredged in Florida by Mr. Pourtalès will clearly show.

The mere presence or absence of this so-called subanal plate cannot be of itself sufficient grounds for uniting with the Salenidae such forms as Acrosalenia, any more than the presence of four anal plates in Parasalenia removes it from Echinometradae to place it among the Echinocidaridae. I am inclined to doubt, therefore, the propriety of placing Acrosalenia, as limited by Cotteau, among the Salenidae; and to question the wisdom of removing Goniopygus from it, as it evidently had, like Salenia, the interambulacral granules carrying the second kind of club-shaped spines observed in Salenia, as well as the sutural impressions of the abactinal system which are wanting in true Acrosalenia. Nor do the spines, as far as they are known, warrant such an approximation. The genera of Salenidae have evidently been too much multiplied. The single character of the position of the anus separating Peltastes from Salenia is not, according to analogy, of any generic value; it may be a convenient section of Salenia, but even that is doubtful, to judge merely from the position of the anus, which may be very considerably to one side or the other, as in young Echini; this seems to support the view taken by Forbes, of the identity of Salenia, Peltastes, and, as Cotteau has shown, also of the identity of Salenia and Hyposalenia. When we know something more than we now do of the spines of Salenidae, the identity of these genera may be proved more conclusively. The spines of Goniopygus thus far discovered show an analogy to those of our Salenia; they evidently had small curved spines, but the larger spines were more or less club-shaped and ribbed at the extremity.

Having adopted the view taken by Forbes of the affinity of these genera, borne out by the shifting position of the anus in the anal system of Echinidae, I have no grounds left for separating, as I formerly did, this species as an independent genus from Salenia, with which I therefore now unite it. From what has been said I can see no reason for finding in Salenidae something analogous to the exclusion of the anal system from the abactinal system in the irregular Echini; on the contrary, I am led to consider the conditions there prevalent as eminently embryonic, and to retain, very nearly as it had been done by Agassiz, the limitation of the family and its position as intermediate

between the Cidaridae and the Echinidae, forming a connecting link between them, combining many features of the Cidaridae proper with true features of the Echinidae, and to consider it as a subfamily of the Cidaridae. The absence of the continuation of the ambulacral tubes through the imbricated scales of the actinal membrane is not an objection to placing them among the Cidaridae, as we find in the Diadematidae similar differences (Diadema and Asthenosoma.

Salenia varispina.

! **Salenocidaris varispina** A. Agass. 1869. Bull. M. C. Z., I.
! *Salenia varispina* A. Agass. 1872. Rev. Ech., Pt. I.

Pl. III. f. 8–14.

The general appearance of this Salenia (*Pl. III. f. 8*) is that of a young Dorocidaris papillata. The primary spines are enormous, twice the diameter of the test in length, of a brilliant white color, and of all shapes. Some of them are uniformly tapering, others swelling at about one third the distance from the base, others flattened and curved, but all finely longitudinally striated and loosely covered with sharp spines, irregularly arranged along the body of the spines. The secondary spines, as well as the greater number of the spines of the ambulacra, as far as the ambitus, are short, club-shaped, sometimes curved and flattened, longitudinally striated with slight serrations. These short spines give to the median interambulacral (*Pl. III. f. 12*) and ambulacral (*Pl. III. f. 14*) zones the aspect of the corresponding zones of Cidaris; but they are not, as in Cidaris, arranged in a circle round the base of the primary spines. These small spines, as well as the whole abactinal area, are covered with prominent, dark violet pigment cells, standing in striking contrast to the white primary spines. The abactinal system has the structure of that of *Salenia,* but the position of the anal system is that of *Hyposalenia.* The imbricated buccal membrane is covered thickly with plates arranged somewhat as they are in *Echinocidaris;* the ten buccal plates, placed half-way between test and teeth, are sparingly covered by pedicellariæ.* The primary tubercles of the interambulacral area are large, arranged in two vertical rows in the two areas; those of the ambulacral area are smaller (*Pl. III. f. 10*), and diminish rapidly towards the abactinal pole; the median interambulacral space is occupied by two vertical rows of small secondary tubercles. The primary tubercles of both areas are imperforate, but distinctly crenulated. Near the actinostome the ambulacra flare slightly, somewhat as in Hemicidaris. The pores are small, placed in pairs far apart, one

* I could find no pedicellariæ upon the test of the single individual collected.

above the other, so that there seems to be, as far as I could see, but a single pair of pores for each ambulacral plate, though near the mouth they are somewhat closer, differing in this respect totally from the structure of the poriferous zone of any other fossil *Salenia* with which I am acquainted; for in all of them we have a large number of ambulacral plates with the pores closed together. As in *Salenia*, the indentations of the actinostome are very slight (*Pl. III. f. 9*). The abactinal system covers nearly the whole of the abactinal part of the test; the anal system is eccentric (*Pl. III. f. 1.*) There is a marked difference in the size of the genital plates, the three posterior ones being much larger than the two anterior ones; the reverse is the case of the ocular plates. In the largest genital plate there is a trace of the madreporic body, corresponding to the position of the axis assigned to it by Forbes, Müller, and Wright, which cuts the symmetrical axis of the subanal plate at an angle; this is the case also with the angle made by the axis of the madreporic body and the first anal plate of young Echini; the position of the axis passing through the anal plate has no definite relation to the madreporic body. The anal opening is covered by small plates, as in other Echini (*Pl. III. f. 11*). The whole abactinal system is studded with embryonic spines (*Pl. III. f. 13*), which are longest along the exterior edge of the abactinal system, thus separating it most distinctly from the test. The sutures between the plates are sharply cut with deep pits at the angles of junction of the genital and subanal plate, and of the ocular and genital plates. The three larger genital plates have also pits in the middle of their line of junction with the subanal plate. The genital openings are large, placed in the middle of the plates.

Off Double Head Shot Key, 315 fathoms.

ARBACIADAE.

Family **Arbaciadae**, GRAY, 1855. Proc. Zoöl. Soc. London.

ARBACIA.

Arbacia GRAY, 1835. Proc. Zool. Soc. London.

Test thick, moderately large, subconical, actinal surface flattened. Ambulacral areas narrow, poriferous zone exceedingly narrow above ambitus, composed of simple vertical pairs, but becomes greatly petaloid owing to flattening of test near actinostome. Tubercles of uniform size, neither perforated nor crenulated, forming two irregular vertical rows in the ambulacral zone, and from four to twelve in the interambulacra, arranged at same time in more or less regular horizontal and vertical rows. Actinostome large, no deep cuts, but very prominent ambulacral lips. Auricles disconnected, teeth like those of Diadematidae and Cidaridae. Anal system composed of four large plates. The bare space of median interambulacral space is due to the resorption of the large tubercles, changed into a coarse granulation which is crowded with pedicellaria along the ambulacral area. Spines stout, long, often spathiform, having a peculiar internal structure partly resembling that of Cidaridae. Buccal membrane bare.

Arbacia punctulata

! *Echinus* **punctulatus** LAMK. 1816. Ann. s. Vert.
! **Arbacia** *punctulata* GRAY, 1835. Proc. Zoöl. Soc. London.

Pl. II. f. 4; Pl. V. f. 1–18.

The species of Arbacia have been too much multiplied, owing to the predominance given to characters which are now known to be either due to differences of age or to very variable features. The character of the abactinal system, the number of coronal plates, with the mode of arrangement of the interambulacral tubercles, as well as the proportions of the actinostome, furnish us with characters by which we can readily distinguish the species enumerated in this Revision. The two species found in the Atlantic are easily distinguished by the great difference in size of the abactinal system, the genital plates forming in A. punctulata a large prominent pentagon; the ocular plates are small and frequently reach the anal system, though usually they are excluded from it; the coronal plates are

high, the tubercles of the interambulacral space distant, separated by crowded miliaries, rarely forming at ambitus more than three rows on each side of the median line, of which usually but one row reaches the apex; though in the specimens from the northern localities we frequently have two and even three of the vertical rows encroaching upon the bare areas reaching well towards the abactinal region. The spines are long, moderately stout, frequently exceeding in length the diameter of the test.

The color, when alive, varies greatly; from a deep violet, almost black, to a straw-color, or spines tipped with violet-brown; dry, denuded tests are usually grayish, with more or less pinkish tint near apex, or light greenish-gray; the poriferous zones being in each case of darker tint than test.

Number of (Interamb.) Primary Tubercles.	Number of Vertical Rows (interamb.).	Diameter of Abactinal System.	Diameter of Actinal System.	Height.	Diameter.	Length of Spine.
16	7	13.4	23.5	29.	47.5	
15	7	12.	22.2	23.5	44.8	36
12	5	8.9	18.	18.7	32.3	29
10	4	7.	11.8	12.	21.	28

Müller was the first to call attention to the difference in the tentacles of the abactinal part of the ambulacral system of this genus. They are pointed, as in Diadema, having no sucking disk, and when fully expanded (as in *Pl. V. f. 1, 2, 3*) give to the Sea-urchin a very striking appearance, forming tufts extending far beyond the spines of that part of the test. These pointed tentacles are flattened in one direction (*Pl. V. f. 6, 7, 8*), they are capable of enormous expansion (*Pl. V. f. 3*), but do not appear to act as rapidly as those provided with suckers, which contract at least contact, while the pointed tentacles can be considerably disturbed before they are drawn in.

The mode of moving of Arbacia is quite different from that of our common Strongylocentrotus; instead of slowly dragging itself along by means of the suckers of the actinal surface, it makes free use of its spines, and by a sort of tilting motion advances quite rapidly. The spathiform shape of the spines around the actinostome in species of this genus is undoubtedly due to the wear and tear produced by this means of locomotion,* which enables them to travel quite rapidly over the ground, though the slower mode of propulsion by means of the sucking tentacles of the actinostome is not unfrequently employed by them when climbing.

* There is formed a sort of cap at the extremity of the actinal spines, found in all the species of Arbacia, which Desmoulins has figured for several species in the Actes de la Soc. Linn. de Bordeaux for 1870, and which is replaced as fast as worn out.

The South Carolina specimens are usually brick-red color in the bare interambulacral spaces with darker sutures, the spines are tipped of same color, but fade gradually towards base into a light-colored violet, or even pale yellow. The tentacles are yellowish-white; the few pedicellariæ found upon test (upper part) are of a dull white color.

In the youngest Arbaciadae observed, we have already four anal plates (*Pl. V. f. 9*). The abactinal system of very young specimens is remarkably prominent, occupying more than one half the abactinal part of the test (*Pl. V. f. 11.*) The whole abactinal part of the test is deeply pitted, Trigonocidaris-like (*Pl. V. f. 11*); the rudimentary tubercles, covering a part of the abactinal part of the test, are connected by ridges (*Pl. V. f. 11*), which are gradually resorbed and reduced to the granulation found upon the coronal plates of this genus. The primary tubercles are at first limited to the ambitus, surmounted by short stout lanceolate spines, Podophora-like (*Pl. V. f. 9*), gradually becoming more slender and proportionally longer with increasing age (*Pl. V. f. 12, 13, 17*), — the opposite of what takes place in Strongylocentrotus, Cidaris, and most young Echini. The rudimentary spines are not seated upon tubercles; they are club-shaped, somewhat similar in shape to those of Podocidaris. The poriferous zone has in the earliest stages the structure found in the adult, only it does not widen at the actinostome (*Pl. V. f. 15*). The ratio of the actinostome to test does not vary greatly in different stages of youth; the edge of the actinal system forming the groove of the gills is turned back but slightly in young, the lips taking the place of cuts becoming more prominent with increasing age. The separation of **Agarites** and **Tetrapygus** to represent the groups with bare or crowded interambulacra is not natural, depending upon the greater or less resorption of the rudimentary tubercles formed in the earlier stages. It is very common to find young of Arbacia punctulata which would pass for young of Tetrapygus, and young Arbacia pustulosa which would pass for young Agarites. Owing to the independent growth of the plates of the poriferous zone, we have either three or four pairs of pores for each ambulacral plate; the same is the case with other Oligoporidae, as limited by Desor, showing that the division he has made, convenient though it is as a key for the easier grouping of genèra, is yet not strictly reliable, the mode of growth of many Polyporidae showing in their young stages that they have but a small number of pores for each ambulacral plate, which places them among the Oligoporidae; but, owing to the independent growth of the plates

of the poriferous zone in older stages, they seem to belong to the Polyporidae.

The changes which the tubercles undergo in their growth are very marked; it constantly happens that primary tubercles, in way of formation, become resorbed by the rapid growth of the test; at least, I can account for the variation of the abactinal part of the interambulacral areas in no other way (compare *f. 14, 16, 18, Pl. V.*). Young specimens of such allied species as A. punctulata and A. pustulosa can readily be recognized by the differences of the abactinal system, which is quite pentagonal in young specimens of A. pustulosa (*Pl. V. f. 19, 20*), while the position of the ocular plates relatively to the genital plates presents in this system a totally different appearance from A. punctulata (*Pl. V. f. 14, 18*), where the ocular plates project beyond the line of the genital plates.

The variations which occur at different stages of growth of this species show how difficult it must be to distinguish the various species which have been described at different times, many of which undoubtedly rest upon no more substantial basis than variations due to peculiarities of young stages which have been more or less persistent. The adult (when examining a large series) shows no less liability to variation in the height of the coronal plates, the size of the tubercles, their number upon the sides of the test, and the relative number of the larger and smaller tubercles, as well as the spines they carry; the sculpture even of the plates of the abactinal system, and their shape and size, being subject to considerable variation.

The specimens collected by Mr. Pourtalès seem to show conclusively that the species distinguished as *E.* **Davisii** in the second number of the Museum Bulletin is only a local variety. Allied species of Arbaciadae are difficult to distinguish; and the characters by which *E.* **Davisii** was separated from A. punctulata are found, in the large series of young specimens collected by Mr. Pourtalès at Cape Fear and Florida Keys, to have no permanence. Lütken considers the *Echinus pustulosus* Lam. as a nominal species; quite a number of specimens of it were brought home by the Thayer Expedition from Brazil; the large series we possess proves its identity with A. aequituberculata.

Littoral, — 125 fathoms.

COELOPLEURUS.

Coelopleurus AGASS. 1840. Cat. Syst. Ectyp.

General appearance of Arbacia: narrow poriferous zone, simple pairs of pores above ambitus, tubercles imperforate and not crenulate. Actinostome small, no cuts; tubercles of median interambulacra have a broad bare space entirely covered by minute granulations, forming undulating zigzag lines from one side of the interambulacrum to the other. The tubercles of ambulacra extend to the apex in two more or less irregular vertical rows.

Sutural impressions along median line, at junction of ambulacral plates only on the actinal side, do not extend to the ambitus.

The spines, as far as they are known from the only living species, are extraordinary, far surpassing in length those of the Diadematidae in proportion to the test. They are long, curved triangular spines, tapering very gradually, while on lower surface they resemble those of the other Arbaciadae, and have the same cellular structure so characteristic of Arbaciadae. Outline of test less conical than in Arbacia.

Coelopleurus floridanus

! *Coelopleurus* **sp.** A. AGASS. 1871. Bull. M. C. Z. III. p. 455.
! *Coelopleurus* **floridanus** A. AG. 1869. Rev. Ech. Pt. I.

Pl. IIᶜ. f. 14, 15.

Among the Echini collected by Mr. Pourtalès in 1868–1869, were numerous fragments of spines of Sea-urchins which I was unable, at the time of writing the Preliminary Report, to refer to any genus of Echini known to me. I am able to give some definite account of the spines, having while in Paris had the opportunity—thanks to Professor Bayle—of examining Michelin's collection now in the École des Mines, containing, among other types, a remarkable Sea-urchin of which only a single specimen exists, described by Michelin, in Annéxe A to Maillard's Notes sur l'Isle de Bourbon, in 1863.

This Sea-urchin he named **Keraiaphorus Maillardi**; it was brought up from a depth of two hundred metres on a fishing-line, and was called **Keraiaphorus** on account of its long curved spines, resembling the antennæ of Cerambycidae. The fragments of spines (*Pl. IIᶜ. f. 14*), collected by Mr. Pourtalès off Tennessee Reef, at a depth of one hundred and sixty fathoms, belong to this genus, but differ sufficiently in appearance to show they do not belong to the same species. They are of a bright vermilion on the con-

cave part of the spine, and a light pink on the opposite side; the extremity of the spine is white for a considerable distance; the spine is slightly curved from the base; a section of the spines (*Pl. II^c. f. 15*) shows them to be somewhat triangular, with rounded sides, the long convex side of the triangle being placed on the side of greatest diameter of curvature of the spine, and the short slightly concave or straight sides on the concave part of the spine. The spine is nearly solid, with the exception of a small annular space, nearer the centre than the periphery, made up of one row of large triangular limestone cells, such as are so characteristic of spines of Echini; the central part and the periphery of the spine consist of very minute circular cells, similar to those of Cidaris spines, closely packed together, presenting a homogeneous structure; in consequence, the outside of the spine is not striated, either longitudinally or transversely, and shows simply a homogeneous close granulation, like very fine marble. The longest fragments are about two inches in length, and, to judge from analogy with **Keraiaphorus Maillardi**, they must have attained a length of at least five or six inches. It is to be hoped that future explorations will bring to light this interesting Sea-urchin, as the only specimen thus far found is not in such a state of preservation as to enable us to ascertain its affinities perfectly satisfactorily.

As far as an examination would allow, Keraiaphorus is identical with Coelopleurus, as had already been suggested by Lütken. It has the same abactinal system, the broad ambulacral zones compared with the interambulacral area, though not quite so sunken as in the fossil species. The arrangement of the pores is the same in arcs round the base of the primary tubercles; the genus is closely allied to Arbacia. There are some discrepancies between the description of Michelin and his figures: the tubercles are not perforated nor crenulated, the general structure of the genital and ocular plates is similar to those of Arbacia; unfortunately the anal plates are not preserved, and Michelin says nothing about them. The peculiar structure of the bare portion of the abactinal part of the interambulacra is not sufficiently brought out in Michelin's figures; in the specimen, ridges of small tubercles, running in S-shaped curves across this bare part of the interambulacra from the base of one plate to the angle of the opposite plate, are quite prominent and fully as marked as in the best figures of Coelopleurus given by Cotteau in the Actes de la Société Linnéenne de Bordeaux, *Pl. XII. f. 4, Vol.* XXVII. The spines of Coelopleurus are as yet not known,

unless the spines cited under the name of *Cidaris* **incerta** D'ARCH., in Mém. Soc. Géol. Vol. III. 2d Ser. Mém. 6, p. 420, *Pl. X. f. 11,* found in the same beds as those containing Coelopleurus, should turn out to be the spines of this genus. They greatly resemble the smaller, shorter, and straight spines of Keraiaphorus found round the actinostome, as was suggested to me by Mr. Vaillant of the École des Mines.

Nor is there any mention made of the sutural impressions found between actinostome and ambitus in the median ambulacral space. These impressions were first noticed by Cotteau* in a fossil species (*C.* **Delbosii**) from the lower tertiaries of Gironde; although Michelin has not described them, the accurate pencil of Humbert has not failed to show them in the figure of the test, as seen from the actinal side (in *Pl. XIV. f. 2,* of Michelin's paper).

It is interesting to note in this connection the existence of a fossil species of this genus from the London Clay, described by Forbes in his Brit. Tertiar. Echinoderms, under the name of *Coelopleurus* **Wetherelli**; we have also in the Tertiaries of Alabama and of Bordeaux species of Coelopleurus.

PODOCIDARIS.

Podocidaris A. AGASS. 1869. Bull. M. C. Z., I.

Test regularly arched above, flat below, depressed abactinal surface, surrounded by raised ambulacral ridges; actinal system resembling that of Arbacia; primary tubercles carrying large, spindle-shaped spines, confined to lower surface. Actinal membrane imbricated only towards centre from the buccal plates. Abactinal part of test covered by spines not articulated, rising directly from test; median ambulacral and interambulacral spaces deeply pitted by depressions surrounded by the ridges extending from the base of the rudimentary club-shaped spines. Poriferous zone narrow; a single vertical row of pairs of pores; abactinal system large, resembling that of Arbacia; anal system covered by four large plates.

Podocidaris sculpta

!**Podocidaris sculpta** A. AG. 1869. Bull. M. C. Z.

Pl. IV. f. 8–16.

This species has, at first glance (*Pl. IV. f. 8*), the general facies of a young Arbacia, with a depressed abactinal surface, the ambulacra rising in ridges

* Échinides Nouveaux, Rev. Mag. Zool., August, 1864, p. 105, *Pl. XIV. f. 10.*

above the surface. The large primary spines are confined to the lower surface as in Colobocentrotus, the primary tubercles scarcely extending beyond the ambitus in the largest specimens obtained (*Pl. IV. f. 9, 10*). These tubercles alone carry a large, smooth mamelon, while the rest of the test is covered with rudimentary spines (*Pl. IV. f. 10*), arranged, however, in regular, vertical rows, four of which form a distinct, raised band in the median interambulacral zone, flanked by three more, less well defined, placed in a comparatively lower plane, while in the narrow ambulacral zone there are but two such rows, close to the poriferous zone, which is very narrow, the pores being arranged in a single vertical row, as in Arbacia (*Pl. IV. f. 12*). The rudimentary, knob-shaped spines,* strongly serrate, are not carried upon a mamelon, but rise directly from the test, as in very young Sea-urchins, and are connected at their base by a ridge, leaving thus a more or less quadrangular pit in the space between four tubercles (*Pl. IV. f. 13*). This ridge is particularly prominent between the spines of the median interambulacral rows, while in the more irregular rows the ridges are less marked, forming simply depressions in the test, running irregularly. The pits in the ambulacral zone are very marked, and are connected into an irregular groove extending along the whole ambulacral zone, the ridges, starting from the base of the tubercles, extending only part way across the ambulacral area, like spurs and rounded knobs. The whole surface of the test (*Pl. IV. f. 8*) is covered with long-stemmed, articulated pedicellariæ (*Pl. IV. f. 16*), which have a distinct mamelon for their support (*Pl. IV. f. 13*), surrounded by a sort of scrobicular circle, the base of the pedicellariæ forming a ball-and-socket joint with the tubercle, while there is a thin muscular membrane holding them in place, as in true spines, — an additional proof that pedicellariæ are only modified spines, as was made probable by their identical mode of development with spines, observed in the Starfishes and Spatangoids

* We have in the adult of this genus, occurring with articulated spines such as are found in fully grown Echini, rudimentary spines rising directly from the test, as we find them in very young Echini or in all Starfishes, yet associated with pedicellariæ having an articulation playing upon a distinct tubercle, and surrounded by a scrobicular circle. The probable function of the pedicellariæ of scavengers and providers seems tolerably well proved, not only by my own observations in our common Sea-urchin, but also by those of other writers on the pedicellariæ of other genera, where they have been seen clasping small Crustacea, Annelids, and other minute marine animals. Starting from the simple network of the reticulation of the test, we pass gradually to all the forms of spines, whether fixed or articulated, whether appearing as mere knobs or granules, to the complicated articulated spines of Cidaris on one side, or from the same granules through fixed pedicellariæ to the highly articulated and movable pedicellariæ of this genus. To this I shall recur again when describing the pedicellariæ of Echini in connection with other anatomical points.

by Müller and myself.* The abactinal system, placed in a depression of the abactinal part of the test, resembles that of Arbacia, having only four anal plates (*Pl. IV. f. 14*), with large genital and ocular plates, which, however, are not bare as in that genus, but carry small, rudimentary, knob-shaped spines. The genital openings are near the anal system. The buccal membrane carries ten large quadrangular plates, with rounded edges placed near the test, the whole space between them and the mouth being covered by small plates (*Pl. IV. f. 9*); the rest of the membrane is bare. The actinal opening is large, the cuts slight, and the pores are not arranged in arcs near the mouth, as in Echinocidaris. The spines are sharp, flat, spindle-shaped (*Pl. IV. f. 8*) with a prominent ridge running along the middle of the upper surface; the section is triangular, the longest side being the under side, which is convex, the shorter upper sides being concave, as is shown better in the enlarged section (*Pl. IV. f. 15*). The spines are finely granulated longitudinally, with a slightly serrated edge. The large spines, as well as the knobs of the rudimentary spines, are sometimes beautifully colored by dark violet pigment cells, following the arrangement of the granulation. The pedicellariæ have the same coloration. The tentacles, to judge from alcoholic specimens, must have been very large, though not possessed of a powerful disk; being, especially near abactinal pole, blunt, or more or less pointed (*Pl. IV. f. 8*), as in Arbaciadae; the test, when prepared to show the structure, was of a delicate cream-color, upon which the brilliant coloration of the knob-shaped spines stood out in bold relief.

138 to 315 fathoms.

* This genus may be truly said to represent Temnopleurus among the Arbaciadae. It is closely allied to Glypticus, where the primary tubercles are gradually changed to irregularly shaped ridges, covering the abactinal part of the test. For figures of Glypticus see GOLDFUSS, Pet. Germaniæ; and AGASSIZ, Échinod. foss. Suisses.

DIADEMATIDAE.

Family **Diadematidae** Peters, 1853. Monatsb. Akad. Berlin. (emend.)

ASTHENOSOMA.

Asthenosoma Grube, 1867. Jahresb. d. Schles. Ges. f. Vat. Cul.

Test flexible; ambulacral and interambulacral areas composed of narrow plates, in which calcareous deposits are limited to the median ambulacral and interambulacral spaces, the remainder of the plate being more or less membranous. The calcareous part of the plates is pistol-shaped, the but end turned towards the actinostome in the interambulacral area, and turned in the opposite direction in the ambulacra; they lap slightly along the median line in both areas, and turning in opposite directions, give the test a great degree of mobility. This character of lapping of the plates in opposite directions in the two areas was thus far only known among the Palaechinidae (Melonites, etc.). The tentacles are pointed near abactinal area, as in the Diadematidae. The abactinal system resembles that of other Diadematidae, has a small anal system, and approaches more the structure of that of Centrostephanus. There is in each area a principal vertical row of large perforate tubercles; the rest of the plate is occupied by smaller tubercles, similar in structure, arranged in an irregular horizontal line, — a mode of arrangement thus far not found among the Diadematidae. The poriferous zone is not formed of independent plates, the large ambulacral plates are themselves perforated for one pair of pores, the two other pairs passing through small scales, resembling the ten buccal plates of Echini of the membranous part of the large plate; they form three vertical rows of pores, reminding us somewhat of the arrangement of the pores of Hipponoë; the two inner vertical rows passing through the membranous part of the large plate are placed close together; the other vertical row is well separated, placed nearer the interambulacral zone, their structure recalling remarkably the structure of the poriferous zone of Palaechinidae.

Asthenosoma hystrix

! Calveria hystrix W. THOMSON, 1869. Prelim. Rept. Porcup. Exped Proc. R. S.
! *Asthenosoma hystrix* A. AG. 1872. Rev. Ech. Pt. I.

Pl. II^c. f. 1–5.

The probability of the correctness of the view which I took in the Preliminary Report, of referring a small Sea-urchin to Calveria hystrix, is greatly strengthened by finding among some refuse of the dredgings from Florida, collected by Mr. Pourtalès, a couple of plates of Asthenosoma hystrix. They must have belonged to a specimen measuring about one and a half inches in diameter, to judge by a specimen slightly larger, which the Museum owes to the kindness of Professor Thomson, collected by the Porcupine Expedition. The small spines on this specimen show the same structure as those of the young Sea-urchin referred to (Asthenosoma), and figured on *Pl. II^c. f. 3.* Older spines become somewhat trumpet-shaped (*Pl. II^c. f. 4*). The peculiar structure of these spines is well shown in the transverse section (*Pl. II^c. f. 5*), — a structure identical with that of the spines of Asthenosoma varium, which I owe to the kindness of Professor Grube of Breslau. The pedicellariæ also are similar, leaving but little doubt of the generic identity of these two remarkable Sea-urchins.

The young specimen, briefly mentioned in the Preliminary Report, is a small Sea-urchin, about $3^{\text{mm.}}$ in diameter (*Pl. II^c. f. 1, 2*). It is already of a size when a young Diadema has its plates tolerably well defined, and when its spines far surpass the diameter of the test in length, besides being provided with a long anal proboscis, which at once characterizes young Diadematidae This specimen was nearly flat, the outline deeply cut at the ambulacra (*Pl. II^c. f. 1*), the interambulacra projecting as large lobes beyond the general outline; the whole test was made up of small limestone cells (*Pl. II^c. f. 2*), and evidently was quite movable, though tough in its present condition; there were deep actinal cuts in the centre of the ambulacral field (*Pl. II^c. f. 1*), the actinal membrane unfortunately was not well preserved. The spines were very short (*Pl. II^c. f. 3*), and bore about the same ratio to the test which they have in Astropyga and Asthenosoma, the tubercles were not yet separated from the general limestone network of the test, and the spines were arranged in the interambulacral spaces in two irregular main rows, and in one row in the ambulacral spaces, both extending to the abactinal pole from the ambitus, the test round the actinostone being bare (*Pl. II^c. f. 1*).

Florida Gulf Stream, 138 fathoms.

DIADEMA.

Diadema Schyn. 1711. Thes. Imag. (Peters. emend.)

Outline of test slightly pentagonal, flattened at both poles, test moderately thin. The tubercles of the ambulacra somewhat smaller than those of the interambulacra, arranged in two vertical rows. The tubercles of both areas are crenulate, perforate. The poriferous zones are narrow, the median ambulacral region much broader than the poriferous zone, but the ambulacra narrow compared to width of interambulacra, and often rising considerably above them. The pores are arranged in simple pairs, forming arcs round the adjacent tubercles. The spines are all of same nature, hollow, closely verticillate, and very long upon both areas, often three and even four times the diameter of test in length. The milled ring at base very large and prominent, and rapidly tapering to the width of shaft, which is maintained to extremity. The actinal system is large; there are ten broad cuts, not very deep, but provided with thin processes diverging from them. The actinal membrane is thin, barely strengthened by small limestone plates. The ambulacral suckers are provided with suckers on lower surface, but above the ambitus, up to the abactinal system, they are pointed as in Arbacia.

The bare part of the sunken interambulacra extending from the genital plates branches and extends on either side of the outer main tubercles. The abactinal system is made up of five large, pointed, triangular genital plates, the genital openings placed in a pit near outer extremity. The ocular plates are small, regularly intercalated between the genital plates. The anal system is covered by a thin naked membrane, only strengthened near genital plates by a row of small plates, anal opening at end of a tube extending like a proboscis three to four times the length of the anal system. Teeth large.

Diadema setosum

! *Diadema setosa* (**Gray**), 1825. An. Phil. p. 4 (non Rumph).

Pl. II^b. f. 6–10; Pl. II^c. f. 6; Pl. IV^a. f. 1; Pl. VI^a. f. 5.

I have been unable, after repeated examinations of a large series of specimens from many localities, to distinguish more than two species of Diadema. Bölsche had already called attention to his inability to separate Diadema antillarum from Diadema Savignyi; and I have to acknowledge that the different species I attempted to discriminate from various localities in the

Pacific and Eastern seas cannot be maintained, with the exception of Diadema mexicanum. I add for the sake of comparison the measurements of the only two species of Diadema which seem to me to be based upon permanent characteristic differences.

The height is extremely variable in all species of Diadema, the abactinal system being frequently sunken considerably below the level of the abactinal parts of the ambulacra, which rise like prominent ridges above the depressed median interambulacral space. In the specimens of Diadema mexicanum I have thus far examined this is rarely the case, the abactinal region is but little sunken. The connecting ridges of the auricles are prominent, the auricles themselves triangular, festooned, but less powerful than in the Mexican species.

Diameter Abactinal System.	Diameter Anal System.	Diameter Actinal System.	Diameter of Test.	No. of Primary (interamb.) Tubercles	
23	13.5	40.	90.	17	D. Mexic.
		35.	86.		D. setosum.
13	7.2	32.9	62.	15	D. Mexic.
14	9.	28.	66.	15	D setosum.
13	8.	27.5	51.5	13	D. Mexic.
		22.4	46.0	14	D. setosum.

The spines, as a usual thing, are more slender and the verticillations closer than in the Mexican species; the miliaries small, scattered in irregular, disconnected vertical lines between the primaries, the bare space of median interambulacral row generally extending to the fourth coronal plate from the abactinal pole.

The original specimen of Lamarck of *Diadema turcarum* in the Jardin des Plantes was from Martinique.

Littoral to 17 fathoms.

In the young of both Diadema and Echinothrix the spines are proportionally larger, and being so much less numerous, give to young Diadematidae a peculiar facies, — E. calamaria-like (*Pl. II^c. f. 6*). We find also in young Diadema characters in the actinal membrane differing from the adult; the peculiar grouping, in five separate clusters,* of the buccal ambulacral plates which appear first, is soon lost by the encroachment of the

* In the Preliminary Report, misled by this embryonic character of young Diadematidae, I took it for granted that Echinodiadema of Verrill, in which these plates are covered with short spines, were only an embryonic feature. I have since that time had the opportunity of examining the buccal membrane of Centrostephanus of Trichodiadema, and find that large specimens of these two genera have identical plates, covered by spines, with those of Echinodiadema, and that this character is an excellent one to distinguish Centrostephanus (= Trichodiadema = Echinodiadema) from the true genus Diadema in addition to its other characteristic features.

smaller interambulacral plates, and in older specimens the plates become deeply embedded in the buccal membrane. The pores at first are placed in a vertical row in very young specimens; they then become arranged in arcs of three or four pairs: with increasing age the median rows of interambulacral tubercles assume the arrangement found in the adult. Owing to the rapid growth of the spines in the young, the extremity, and frequently the greater part of the spine almost to the base, is hollow; but as the young increase in age they become more solid at the base, and further up in proportion to their age. The anal tube of small specimens is very striking, being as prominent as the anal proboscis of some species of Comatulae (*Pl. II^c. f. 6*). The anal membrane is still quite flexible in the adult, and forms a proboscis, though shorter proportionally than in the young, as Grube pointed out some time since.

In very young *Echinothrix turcarum* the spines become early solid, and differ generally strikingly, on account of the close verticillation forming a longitudinal striation, from those of Diadema or of the other species of Echinothrix. I was inclined formerly to retain for this species the generic name proposed first by Gray, but having examined a large series of this species in the Godeffroy Museum, I find that although the spines are more closely verticillate, yet the solidity — the main character upon which the generic separation was based — was not so universal as I had been led to suppose, and the structure of the test presenting no feature by which the species of this group could be distinguished generally, they have been united with Echinothrix.

ECHINOMETRADAE.

Family **Echinometradae** GRAY, 1855. Proc. Zool. Soc. London, p. 37.

STRONGYLOCENTROTUS.

Strongylocentrotus BRANDT, 1835. Prod. Descript. An.

This genus was first established by Brandt for the typical *Echinus* **chlorocentrotus** = Dröbachiensis. It has, in the subsequent limitations of the genera into which Echinus has been divided by Agassiz, Desor, A. Agassiz, Lütken, Verrill, completely escaped their attention. It includes all species having a somewhat circular or subpentagonal, regularly arched or slightly

depressed test, with smooth, imperforate, not crenulate tubercles of unequal sizes, forming primary and secondary vertical rows. Pores arranged in arcs of at least four to five pairs. Actinostome decagonal; very slight cuts; buccal membrane bare; spines moderately slender, longitudinally striated, longer proportionally than those of true Echinus, and more slender than those of Sphaerechinus.

The analysis of the mode of growth of the pores shows how impossible it is, upon the mere question of quantity or direction of the pores, to subdivide this genus as has frequently been attempted; and now that it is associated with the Echinometradae, instead of the Echinidae, where we find variations similar to those noticed in Strongylocentrotus, the homogeneous nature of the genus as now limited cannot fail to be apparent, and however convenient the former generic sections may be as keys for ready identification of species, we cannot allow them greater value. The modifications of the poriferous zone upon which these so-called generic distinctions have been based are in this case simply quantitative modifications, not involving a single structural feature, as an examination of the analysis of the plates of the poriferous zones of Echini apparently shows; the petaloid appearance of the zones immediately round the actinostome is a mere result of the flattening of the test, and the direction of the arcs of pores due to the greater or less rapid growth of the new additional plates of the poriferous zones or of the primitive plate of each arc. If the latter grows rapidly, the arcs are open and transverse (Loxechinus); if it is the older plates which grow very rapidly, we have very regularly arched arcs, each arc (Toxocidaris) of greater or smaller size if the new plates are added only at the upper part of the arc; while if they are also added at the open end of the arc, the arcs are more vertical (Sphaerechinus), a structural feature which, taken into connection with the actinal cuts, seems to entitle the section (Sphaerechinus) to rank as subgeneric.

Strongylocentrotus Dröbachiensis

! ? *Echinus* **Dröbachiensis** MÜLL. 1776. Zool. Dan. Prod.
! *Strongylocentrotus Dröbachiensis* A. AG 1872. Rev. Ech. Pt. 1.

Pl. IV^a. f. 2, 3, 4; Pl. IX; Pl. X.

After a careful re-examination of the whole subject I am unable to distinguish more than one species of Strongylocentrotus in the circumpolar specimens thus far collected. I am aware that there are marked local differences,

and can readily see how with small series it would be possible to establish the species generally recognized as S. chlorocentrotus, S. granularis (granulatus Gould). Careful measurements of a number of specimens of the alleged species are here given, tabulated according to their origin, and fail to show any characters by which they can be separated.

The thickness of the test is extremely variable, the specimens from the northwest coast generally are very much thinner (chlorocentrotus), though those which are known as carnosus are more like Dröbachiensis, and have a somewhat thicker shell, while in granulatus it is often quite thick. The shape and outline are very variable, as seen from measurements. Coronal plates are of median height, with but one large tubercle on each plate, forming the two principal vertical rows of the interambulacral space, the rest of the plate being closely covered by secondaries, so as to form irregular vertical or transverse lines, as is usually the case in granulatus; or the vertical lines are more regular (as in Dröbachiensis), the secondaries being larger and the smaller secondaries less prominent, these being the greatest extremes. The same general features of arrangement hold good in ambulacral and interambulacral spaces. Though the extremes have been mentioned, we find the loose arrangement of granulatus combined with the thin and thick test, and with the broad and narrow poriferous zone. The arcs of pores of granulatus are straighter, but in Dröbachiensis said to be more vertical. This depends upon the height of the vertical plates; when arcs are straight, the poriferous zones are separated by two irregular oblique rows of minute tubercles which follow the curve of the poriferous zones. The number of pairs of pores varies greatly; in one and the same specimen we find one zone with six pores near ambitus and generally but five above it, when in the next zone there may be five or six above as a general thing.

Of the ocular plates two reach the anal system and the others are excluded. The madreporic body is very much larger than other genital plates, which are short-sided near the anal system, and long, pointed, extending beyond the level of the ocular plates, with pretty large genital openings. Secondaries covering loosely the whole abactinal system; anal system large; exterior row of plates largest, gradually diminishing towards anus. Spines vary greatly in length, comparatively slender, greenish-purple, or violet, or flesh-colored, or even cream-color. Buccal membrane thin, with few small plates irregularly placed in continuation of ambulacral system. Auricles slight, with large opening; shallow ridge connecting them.

Chlorocentrotus.

No. Interamb. Tubercles.	Diam.	Height.	Abactin. System.	Anal. System.	Actinal System.	Width Porif. Zone.	No. Pores.	Spine.
24	82.	32.7	18.5	9.	23.4	6.	6	14.
19	62.5	29.	14.	7.	19.9	4.5	6	13.
18	43.4	22.3	11.9	5.1	15.5	3.2	6	8.9
16	34.	18.2	8.9	4.1	12.	2.9	6	7.2
13	22.9	10.4	5.	2.8	9.3	1.9	6	7.1

Dröbachiensis.

21	60.	33.	13.	7.2	19.	4.6	6	15.
16	48.2	21.4	12.	7.	17.9	3.5	6	12.6
15	44.4	19.	11.	5 6	15.	2.5	6	11.5
14	45.2	23.	11.1	5.8	16.5	3.0	6	
18	50.	21.3	12.4	6.	16.3	2.9	6	
11	20.5	9.	5.8	2.5	19.5	1.8	5	

Granulatus.

24	78.2	38.2	19.	10.3	23.	4.9	6
23	68.	39.5	15.6	6.2	20.	5.0	6
20	58.4	30.	12.5	6.	17.	4.1	6
21	53.	29.3	12.	5.1	17.4	3.9	6
19	52.	26.	11.8	4.1	16 2	4.	6
16	39.	19.1	9.2	5.	14.3	3.	6
14	38.	19.4	7.4	3.9	11.5	2.9	6
12	22.3	10.7	6.1	3.3	10.2	2.	6
10	13.	6.9	4.	2.	6.4	1.1	6

In the young Sea-urchins where the Pluteus has only been resorbed recently (*Pl. X. f. 1*), we find the spines limited to the edge of the flat test, not articulated. They are few in number, and remarkable for their size. There is no trace of an anal system, the anus still opening by the side of the mouth as in young Starfishes. The tentacles equal in length the diameter of the test. The whole test is thickly covered by dark crimson pigment cells. The spines, which are at first mere projections of the calcareous network of the shell, become more fan-shaped in older specimens (*Pl. X. f. 4*) as they extend further towards the abactinal pole. The odd tentacle expands to a remarkable extent, sometimes to three times the radius of the test. The four tentacles of each ambulacral space are short and stout, and capable of but limited expansion and contraction (*Pl. X. f. 3*), the whole actinal membrane being covered by an open plating of limestone cells. The actinal system is circular (*Pl. IX. f. 2*), without any notches, large, with teeth occupying but a small part of the actinal space, extending as five narrow wedges from the centre to edge of test. The tubercles are also comparatively large. These embryonic features are soon lost, pedicillariæ begin to appear, the spines lose their fan shape, becoming

more elongate, though still serrate; the tentacles are more numerous; the anal system is developed as a single large plate (*Pl. X. f. 2*), the anus opening to one side of it; and we commence to trace distinct sutures separating the coronal plates, new plates being added at the abactinal pole round the anal system.

In young specimens of somewhat less than one eighth of an inch in diameter ($3^{mm.}$), having five : six ambulacral plates (*Pl. IX. f. 3*), we find features totally unlike those belonging to the genus Strongylocentrotus. The anal system is closed by one large circular plate occupying the whole of the space between the genital plates. A line passing through the madreporic body and the anal plate does not pass through the symmetrical axis of the plate, but at a considerable angle, showing (as is the case in all young Sea-urchins) that we cannot use the anal plate, or opening of anus, as a guide for the determination of any one axis in Sea-urchins. So that the attempt made to define the longitudinal axis by a line passing through the axis of symmetry of the subanal plate does not give us any fixed position. This attempt was only introduced from taking the subanal plate of Salenia as the guide in fixing this axis, but if the subanal plate of Salenia is only the homologue of the large anal plate of young Echini (*Pl. IX. f. 3, 6, 8*), it is natural to find the madreporic body to one side of it, as we find in the young of several genera of Echini. The symmetrical axis of the anal plate pointing either to the second or third genital plate (counting from the madreporic body to the left), and as I have shown in my Memoirs on the Embryology of Echinoderms that the plane of the madreporic body was one connected with a fundamental point of structure in the plan of the young Echinoderm, there is no anomaly presented by finding in Saleniae the madreporic body passing asymmetrically through the subanal plate, that being, as is the case in all Echini, its natural position.

In these small specimens we find the pores arranged in vertical arcs of four pairs for each ambulacral plate (*Pl. IX. f. 5*). There are two main vertical rows of primary tubercles in the ambulacral and interambulacral zones, nearly of the same size, surrounded by a few secondary tubercles irregularly arranged; the test is quite flat in proportion to the diameter, and, when seen from below, we find the actinostome of extraordinary proportions (*Pl. IX. f. 4*), occupying fully three quarters of the whole lower part; the outline is scarcely indented; the points of the teeth are blunt, triangular; the membrane is naked, being slightly stiffened by small granules round the at-

tachment to the teeth. The ten perforated plates carrying tubercles, which in the adult are close to the base of the teeth, are found to be close to the test. In a somewhat older specimen, measuring 3.5mm. in diameter and having nine : ten plates, there are traces of four additional minute plates in the anal system (*Pl. IX. f. 6*). There is no change in the arrangement of the pores or of the tubercles; when seen from the lower side, the actinal opening occupies a much smaller proportion of the test (*Pl. IX. f. 7*). The tentacular plates are nearer the centre, and the ambulacral and interambulacral spaces on the periphery of the actinostome are equal, the latter having been the larger in the younger stages. In a specimen somewhat older, measuring 5.1mm. in diameter, the notches of the actinostome are more marked, the opening reduced still further in proportion (*Pl. IX. f. 10*); and in specimens of 8.4mm. in diameter the actinal opening has about the proportions of the adult (*Pl. IX. f. 12*), the ambulacral area is broader than the interambulacral at the periphery, the notches are about as they were in the preceding stage. In the specimen measuring 5.1mm. in diameter, we find the first trace of the open arcs of pores towards the ambitus (*Pl. IX. f. 9*), while the upper tubercles are still surrounded by closed vertical arcs (*Pl. IX. f. 8*). It seems impossible to account for the subsequent arrangement of the pores, except on the supposition that the plates forming the poriferous zone grow independently of the ambulacral plates, and that they are pushed along down towards the ambitus, forming open arcs of four or five or even a larger number of pairs of pores.

In all these stages (*Pl. IX. f. 3–12*), the test was quite depressed; it is only when it attains a diameter of 8.4mm., that the depression is not marked, and the young Sea-urchin assumes the general outline and characters of the adult, as is shown by the greater number of plates of the anal system and the regularly open arcs of pores, as well as the appearance of the secondary rows of tubercles.*

* The same general changes take place in S. lividus as in S Dröbachiensis. In very small specimens, 2.5mm. in diameter, and having four : five coronal plates, we find four pairs of pores for each ambulacral plate arranged in an almost vertical row and but slightly curved. The same is the case in specimens measuring 3.6mm. in diameter, with six : five tubercles when the curve is somewhat more decided. In specimens having seven : eight plates, and measuring 6.3mm. and 8.4mm. in diameter, we find still the same vertical arrangement of the pores. The arcs do not open till the Sea-urchin has attained a diameter of 10mm., when we find in one plate an arc of five pairs of pores, and in specimens measuring 12.7mm., two plates with open arcs of five pairs of pores. Young S. lividus are much more flattened than the young of S. Dröbachiensis, being generally more turban-shaped, while the latter are always very slightly conical. The

ECHINOMETRA.

Echinometra ROND. 1554. De Piscib. (BREYN).

Test thin, elongate, the longer axis making an acute angle with the anterior axis, the madreporic body being placed on the right of this long axis. Tubercles large, imperforate, not crenulate, slightly smaller in the ambulacral area. Poriferous zone moderately broad, pores arranged in very prominent arcs of many pairs. Actinostome large, actinal cuts shallow and often broad. Jaws very powerful, and auricles very massive. Spines long, longitudinally striated, quite stout; there are usually clusters of spines on the ten buccal plates of the actinal membrane,—a feature which distinguishes this genus from the true Strongylocentrotus, with which it is far more closely related than has usually been considered to be the case. The obliquity of the axis passing through the madreporic body and the opposite ocular plate is an embryonic feature, arising from the closing up of the open spiral which forms the first foundation of the Echinus in the Pluteus; when this spiral becomes first closed, it is always eccentric, but becomes symmetrical in the other Echinidae, with the exception of the true Echinometradae where the obliquity remains through the adult stages.

Nowhere among the young regular Echini have I found such great changes in the shape and proportions of the test and spines as in Echinometra. We frequently find specimens of the same size, where in one case the outline is almost circular, the test flattened, covered with long slender spines, while in the other the test is lobed, swollen, high, surmounted by numerous short stout spines. These and all intermediate stages, complicated by the greater or smaller number of primary tubercles, the arrangement of the arcs of the poriferous zone undergoing changes exactly similar to those described in Strongylocentrotus, are found existing in specimens of very different size. This has given rise in a great measure to the confused synonymy attached to our most common species, and renders their identification, if based upon meagre material, almost hopeless.

poriferous zone also is wider proportionally, the actinal opening is larger, and no trace of branchial cuts can be seen in specimens measuring 12.7mm., the arrangement of the miliaries is more regular, and they early have the two vertical rows of primary tubercles well developed.

Echinometra subangularis

! *Cidaris* **subangularis** Leske, 1778. Kl. Addit.

! *Echinometra subangularis* Desml. 1837. Syn., p. 266.

Pl. X^a. f. 2, 3, 4.

Poriferous zone broad; pores arranged in arcs of not more than seven pairs, usually six; pores of a pair large, distant; abactinal system narrow; madreporic genital far exceeds in size the other genital plates, which are small, with large genital openings. What is specially remarkable in the West India species is the great size of the auricles, extending in a T-shaped broad column half-way the length of the polar axis, connected by a robust ridge at base, equalling in height one third of the auricles. Auricular arch small. Actinostome large and pentagonal; the number of coronal plates of ambulacra in young specimens is materially greater than in the interambulacra, but older specimens do not show a striking difference in the size of the primary tubercles of the two areas. The variation in proportion of the test, the structure of the ambulacra near the actinostome (more or less petaloid), the proportions of the spines and the test, are so great that it is only by examining a large series of specimens that good characters, which are but few, can be enumerated to distinguish this from the other species of Echinometra.

The color of the spines varies greatly from a dark violet-green to a deep violet almost black. With increasing age, as the test becomes more gibbous, the coronal plates increase greatly in size, and the primary vertical rows of tubercles often attain an extraordinary size, which has caused them, when flattened, to be mistaken for genuine Stomopneustes.

No. Primary interamb. Tubercles.	No. of Pores.	Diam. Actinal. System.	Diam. Abactinal. System.	Spine.	Diameter.	Height.
10	6	14.8	6.	18.	30.5	14.
11	6	19.	8.1	23.5	41	19.
13	7	21.	9.8	26.5	49.	22.
15	7	25.	11.	47.5	61.	31.
15	7	30.5	14.5	41.	75.	35.3
15	7	30.3	13.4		74.	36.5

From an examination of typical specimens of *Echinus lucunter* Lam. it became evident that Lamarck's species was the common Echinometra, having such an extensive range in the Pacific and Indian Oceans; extending from the Sandwich Islands to the Red Sea. It was with some doubt, however, that the name **Michelini** was adopted in the Museum Bulletin for our common West India species, the varieties of which have served as the type of many species: the large, somewhat oblong, swollen-sided adult, with short

stout spines, has been the *Echinometra lobata* BLAINV.; the flatter, more circular variety, with long slender spines, has even been referred to a different genus, Heliocidaris, by Hupé. Authors generally have referred the young flat stage to *Heliocidaris* **mexicana** AG.

Lütken supposed that the common West India Echinometra was the Echinus lucunter of Linné, and both he and Professor Lovén think the tradition of Linné's species points that way; unfortunately the labels of the Coll. Lud. Ulric. Reginae in the Museum of Upsala have been lost, so that it is impossible with precision to determine what Linné meant, and as there is no doubt as to what Lamarck meant by his E. lucunter, I have retained the name for the common Pacific species, and would have retained for our West India species the name E. acufera, as had been done before by Müller, were it not that the types which have served as the Cidaris subangularis of Leske are still preserved in Erlangen, leaving us no choice in the matter.

It is somewhat remarkable that, with the extensive geographical distribution of this species (the whole coast of Brazil, the Gulf of Mexico, Caribbean Sea, West India Islands, Bahamas, Bermudas, and W. coast of Africa), it should be so limited in bathymetrical range.

Littoral 6 to 7 fathoms.

Echinometra viridis

! *Echinometra* **viridis** A. AGASS. 1863. Bull. M. C. Z., I.

Pl. X^a. f. 1.

At once recognized by its prominent bare abactinal system with equally developed genital plates. The anal plates are large, bare, one or two of the larger ones having a single spine, the genital plates carrying but a single small tubercle near the anal edge; the ocular plates are completely excluded from the anal system, the madreporic plate scarcely larger than the other genital plates. The poriferous zone narrow, the arcs confluent, the pores arranged in arcs of usually five, though sometimes six pairs.

The spines in all the specimens examined are of a dirty green color, tipped with olive, with frequently a white milled ring. The actinostome is nearly circular, the actinal cuts shallow but sharp for this genus, the auricles slender, short, with a large auricular opening and low connecting ridges. The secondary rows of tubercles of the interambulacral space are irregular, made up of small secondaries, and in ambulacra are mere granules.

The tubercles are large and prominent, though the boss is low; the coronal plates are high.

Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	No. Prim. Tub.	No. Pores.	Spine.
37.5	19.	8.5	15.5	4.2	10	6	19 (*worn*)
29.5	14.2	8.5	14.2	3.5	10	5	
29.	14.	7.	13.	3.	10	5	28
21.	10.	6.	12.	2.3	9	5	19

As in Echinometra subangularis there is a flat long-spined variety of Echinometra viridis, distinguished formerly as Echinometra plana, but which the full series now in the Museum collection shows decidedly to hold the same relation to E. viridis which Heliocidaris mexicana AUCT. holds to E. subangularis.

Same bathymetrical range as former species; much less common.

ECHINIDAE.

Family **Echinidae** AGASS. C. R. Ann. Sc. Nat. VI. 1846. (emend.)

TEMNOPLEURIDAE.

Subfamily **Temnopleuridae** DESOR, 1855. Syn. Éch. foss.

TEMNECHINUS.

Temnechinus FORBES, 1852. Brit. foss. Tert. Echinod. p. 5.

Small Echini, test globular, primary tubercles in two principal vertical rows; secondary tubercles irregularly packed round base of primaries and edge of pits situated in median ambulacral and interambulacral spaces. Poriferous zone narrow, confluent, undulating; pores sunken, tubercles smooth and imperforate, actinal cuts slight, actinal membrane bare. Abactinal system prominent, genital plates well developed, genital openings in grooves. Anal system covered by one large conical plate, anal slit on edge of this and covered by three or four small plates. Spines short, slender, somewhat transparent, resembling those of Salmacis; auricles slender and closed.

Temnechinus maculatus

! **Genocidaris maculatus** A. AGASS. 1869. Bull. M. C. Z.
! *Temnechinus maculatus* A. AGASS. 1872. Rev. Ech., Pt. I.

Pl. VIII. f. 1–18.

Having examined lately several species of Temnechini from the London Crag, contained in a fine collection of fossils from the Crag, sent to the Museum by Dr. Quimby of Liverpool, I am inclined to regard this as a living species of Temnechinus, although it presents, even in the largest specimens received, very marked differences from those of Temnechinus figured by Forbes in his British Tertiaries.

This small Sea-urchin was described in the Preliminary Report as Genocidaris maculata (*Pl. VIII. f. 1*). It is closely allied to Opechinus, which Desor separated from Temnopleurus. The spines (*Pl. VIII. f. 5*) resemble in their structure those of Temnopleurus, but are shorter; the Sea-urchin with its spines resembling a Psammechinus, and having, like it, a large number of secondary tubercles, of nearly uniform size, closely crowded together (*Pl. VIII. f. 4*), but of a peculiar chiselled structure round the base of the primaries (so that it may be said that this genus is a Psammechinus among Temnopleuridae), there is a principal row of tubercles in the ambulacral and interambulacral area larger than the others. The poriferous zone is narrow; the pores, separated by an arched ridge, are arranged in an unbroken, slightly undulating, vertical row. The primary tubercles are smooth, imperforate. Near the base of the tubercle in the interambulacral spaces the test is ornamented by pits specially marked near the suture of the plates; in small specimens (*Pl. VIII. f. 11*), the small tubercles are frequently connected by a ridge with the main tubercles, and in still younger specimens (*Pl. VIII. f. 14*), before the secondary tubercles are well separated from the ridges, they form spokes radiating from a hub, similar to the structure of the tubercles in Glyphocyphus radiatus, and some species of Echinocyphus. The genera Opechinus, Microcyphus, Trigonocidaris, and Temnechinus form a transition between Echinus (Psammechinus) and Temnopleurus. The actinal membrane is bare, with the exception of the ten small circular buccal plates. The actinal opening is not large, with slight indentations (*Pl. VIII. f. 2*); in smaller specimens the actinal system is nearly circular (*Pl. VIII. f. 15*), the test is irregularly covered with pedicellariæ, having a blunt head surmounting a long, slender stem, articulating upon a shorter, stout rod (*Pl. VIII. f. 6*). The abactinal system is peculiar, as we find in the largest specimens even

(*Pl. VIII. f. 1*), which appear fully developed, but a single circular plate (*Pl. VIII. f. 3*), slightly conical, occupying nearly the whole anal system, with the exception of a small crescent-shaped anal slit, covered by four very small plates. The genital plates are large pentagonal, with a deep groove, in which is situated the genital opening, having on the anal edge a cluster of three or four small tubercles; the ocular plates are also pentagonal, elongated horizontally, indented slightly. The color of the test is greenish (in alcohol), often mottled with dark violet patches: the spines are of the same greenish tinge, banded irregularly with reddish transverse bands. In other specimens we have the same pattern of coloration, in different shades of green, with white spots irregularly scattered over the surface, or the median ambulacral and interambulacral spaces are colored, the tubercles rising prominently from this deeper background; the anal edge of the genital plates is similarly colored. On *Pl. VIII. f. 30*, is given a part of the test of **Temnechinus globosus** of FORBES, from a specimen considerably larger than the specimen of T. maculatus (*Pl. VIII. f. 1*), when the pits, which exist at the base of the tubercles (*Pl. VIII. f. 4*), are just commencing above, while they are well developed in the part of the test of the fossil species represented, but coincide in the structure of the upper part of the test with the living specimens. The changes due to growth in the recent species of Temnechinus are striking, the different stages from the perfectly smooth uniform granulation of the smallest specimen collected (*Pl. VIII. f. 17*), with its immense actinostome, through those represented in *Pl. VIII. f. 14*, to *f. 11*, and to *f. 4*, would scarcely be credited to belong to the same species were it not for the complete series collected. The different habitus of the oldest and smallest specimen collected is best seen by contrasting (*Pl. VIII. f. 16* and *Pl. VIII. f. 1*) the two extreme sizes of this species collected by Mr. Pourtalès. In the youngest stage (*Pl. VIII. f. 16*), the spines are slightly flattened, pointed, swollen in centre, serrated, longitudinally striated; they equal in length the diameter of the test, are few in number, and remarkably large, here and there some smaller spines having the same structure as the larger, and a few club-shaped embryonic spines, not yet articulated. The test is flat, pentagonal, is not separated into plates, has no abactinal system proper yet specialized, beyond the single large plate of the anal system and the large genital openings, in the limestone network. In a somewhat older stage the spines cover the test more closely concealing the anal plate, they have lost their fusiform shape and take the form of spines figured in *Pl. VIII. f. 18*, still retaining sufficiently the

structure and coloration of the fusiform spines to show their connection. The test denuded and magnified presents the peculiar hub-shaped arrangement of the ridge to form the secondary tubercles round the base of the primaries (*Pl. VIII. f. 14*). When somewhat older the actinostome is much smaller (*Pl. VIII. f. 15*), slightly angular, the genital plates not yet distinctly formed. In the following stage (*Pl. VIII. f. 8, 9*), the pits at the base of the tubercles are quite marked (*Pl. VIII. f. 11*), the spines are about a third the diameter of the test, but have quite the general aspect of those of larger specimens (*Pl. VIII. f. 12*). The abactinal system is well formed, the genital plates rising above the level of test, are pentagonal, deeply grooved for the opening of the genital openings, the madreporic body prominent (*Pl. VIII. f. 10*), and a single conical plate fills the whole of the anal system. The auricles resemble those of some species of Temnopleurus (*Pl. VIII. f. 13*).

The largest specimens collected (*Pl. VIII. f. 1, 4*) have the same structure in the middle of test which is found in the youngest plates of Temnechinus, showing that eventually these incipient pits will fall together, forming pits similar to those of the fossil species (*Pl. VIII. f. 30*). The outline of the test is regularly arched, slightly flattened at top (*Pl. VIII. f. 7*). The changes in the poriferous zone are slight, the zone of the older specimens being somewhat undulating (*Pl. VIII. f. 4*) or angular, while in younger specimens the poriferous zone is vertical (*Pl. VIII. f. 14*); the ridges separating the pairs of pores becoming more distinct with age, and the pores more sunken.

From 30 to 160 fathoms.

Among the Temnopleuridae the changes due to growth are very prominent; hence the difficulty of recognizing the species thus far established, as the descriptions belong to specimens not identical in age. It would be hardly possible to recognize in *Pl. VIII. f. 22* and *Pl. VIII. f. 24* corresponding portions of the test of Temnopleurus Reynaudi; the sharp, deep, rectangular pits at the sutures of the plates (*Pl. VIII. f. 24*), taken with the peculiar anal system of this stage of growth (*Pl. VIII. f. 23*), with its large elliptical anal plate covering nearly the whole anal system, would certainly warrant us in separating these specimens from those with wide, diffuse, triangular depressions at the sutures of the plates (*Pl. VIII. f. 22*), having prominent, isolated, comma-shaped secondaries round the primary tubercles, and an anal system in which, although one plate is much more prominent than the others, yet is relatively small compared to the size of the anal system (*Pl. VIII. f. 24′*).

Similar changes of growth are observed in Temnopl. Hardwickii (*Pl VIII. f. 25, 26*). The secondary tubercles appear at first like radiating spokes. The pits are sharp, rectangular (*Pl. VIII. f. 25*), while in somewhat older stages they are more circular (*Pl. VIII. f. 26*), the secondary tubercles isolated, and eventually these pits become mere smooth, bare, angular spaces at the junction of the plates in the adult. The increase in number of plates of the anal system, due to age, is seen in comparing *Pl. VIII. f. 28* and *Pl. VIII. f. 27*; the anal system undergoing changes similar to those of the anal system of Toxopneustes, Echinus, and the like, where no one plate retains a greater prominence, as is so markedly the case in Temnopleurus, where the plate, originally covering the whole anal system, is peculiarly ornamented, and retains throughout its characteristic features, and is readily distinguished (*Pl. VIII. f. 24'*) in the oldest specimens from the plates subsequently added in younger specimens.

D'Archiac and Haime have figured from the Nummulitic formation of India a number of species, which are usually referred either to Temnopleurus or to Opechinus, which belong to this same genus Temnechinus.

TRIGONOCIDARIS.

Trigonocidaris A. Agass. 1869. Bull. M. C. Z., I.

Small Echini, test thin, regularly arched above, depressed below; actinal cuts slight, actinal membrane strongly imbricated. Two principal vertical rows of tubercles, both in the ambulacral and interambulacral areas; secondaries and primaries connected by ridges raised above test, forming an irregular network of ridges, with more or less deep pits between them; poriferous zone narrow, pores arranged in single vertical pairs, spines longitudinally and laterally striated. Abactinal system large, genital plates excluding smaller ocular plates from anal system, which is covered by four plates.

Trigonocidaris albida

! **Trigonocidaris albida** A. Ag. 1869. Bull. M. C. Z., I.

Pl. IV. f. 1–7.

Small species, in which the primary tubercles have the same structure as in Temnechinus; but, in addition, the whole test is covered by a reticulation of ridges, similar to those of Podocidaris, but more numerous and quite

irregular (*Pl. IV. f. 3*), extending from the base of the different tubercles, both primary and secondary, and uniting them all in a complicated, raised system of network, with irregularly shaped cells, the ridges leaving more or less deep pits, giving the test the appearance of having been gouged out in spots (*Pl. IV. f. 1*). The spines are long, slender, somewhat transparent, longitudinally striated, with slight transverse striation (*Pl. IV. f. 4*). The abactinal system resembles that of Hemipedina, but the anal system is covered by only four triangular plates, one of which is much larger than the others (*Pl. IV. f. 1*). From the fact that in the youngest specimens examined we find them already, I am tempted to suppose they never increase in number, and remain as they are, as in Arbacia. The actinal membrane is, as in some species of Toxopneustes, entirely covered by a number of rather large plates irregularly arranged, the ten buccal plates being but slightly more prominent (*Pl. IV. f. 2*) than the others. The actinal opening is of moderate size, slightly indented; the auricles are exceedingly slender, and disconnected at the extremity. There are but two principal rows of primary tubercles, both in the ambulacral and interambulacral zone, with but five to six minute tubercles seated upon the connecting ridges in the latter zone, and two or three upon each plate in the former. The poriferous zone is narrow; the pores are placed obliquely in an unbroken vertical zone, three to each ambulacral plate, and separated by ridges running from the ambulacral tubercles to the interambulacral zone, similar to those joining the tubercles. The test, as well as the spines, are almost white, the latter having only a slight tinge of yellow when largest. The whole test is covered with pedicellariæ (*Pl. IV. f. 5*), having a large pointed head articulated upon a long, comparatively slender peduncle, seeming scarcely capable of supporting the bulky head.

In younger specimens (*Pl. IV. f. 6*), the reticulations connecting the smaller number of larger tubercles are broader, the pits less numerous and not so deeply cut (*Pl. IV. f. 7*); the secondaries, however, show no regular arrangement, the spines are comparatively longer, the arrangement of the poriferous zone is the same, and the abactinal system does not vary materially from the older specimens figured. The only approach we have to a similar reticulation in any other genus is in Echinocyphus, but then it is limited to a few spurs radiating from the primary tubercles like spokes.

From 40 to 270 fathoms.

TRIPLECHINIDAE.

Subfamily **Triplechinidae** A. Agass.

(PSEUDODIADEMA.) Hemipedina.

Hemipedina Wright, 1855. Brit. Ool. Echin.

The small number of living specimens of the genera belonging to Pseudodiadematidae thus far found renders it extremely difficult to form any opinion of the characters hitherto employed to distinguish the genera allied to Phymosoma and Pseudodiadema. It seems pretty evident that there have been too many generic divisions introduced, but I am unable from the material thus far collected to give any satisfactory limitation of the genera of Pseudodiadematidae, resting as they do upon the presence or absence of crenulation and perforation of the tubercles. For this reason I prefer, until better characters can be pointed out than those upon which I based my separations from Hemipedina of Caenopedina, to regard this genus as identical with Hemipedina, regarding Hemipedina at the same time as a subgenus of Pseudodiadema, from which it differs only in having smooth tubercles, not crenulate, and having deep actinal cuts and smaller ambulacral tubercles.

The genus contains Echini having but two principal vertical rows of tubercles in the ambulacral and interambulacral areas, the ambulacral tubercles smallest, both perforate but not crenulate. Poriferous zones simple, forming arching curves round the primary tubercles. Actinal cuts marked, ten large buccal plates. Abactinal system large, not prominent. Spines long, slender, longitudinally striated. The poriferous zone resembles that of Orthopsis, having also, like it and Echinopsis, perforate but not crenulate tubercles. It resembles Acrosalenia as well as Phymosoma, of which the tubercles are, however, crenulate and not perforate.

Hemipedina cubensis

! **Caenopedina cubensis** A. Agass. 1869. Bull. M. C. Z., I.
! *Hemipedina cubensis* A. Agass. 1872. Rev. Ech. Pt. I.

Pl. III. f. 1–7.

This species is a living representative of the genus Hemipedina of Wright (as emended by Desor, Wright having included in it species of other genera of Pseudodiadematidae). It differs from its fossil representative by the peculiar arrangement of the pores, which have a tendency to arrange themselves

in lateral arcs of three pairs (*Pl. III. f. 4*). The general outline of the test is that of Phymosoma, there are only two rows of tubercles extending from pole to pole; the flatness of the abactinal part of the test (*Pl. III. f. 5*), and the great development of the abactinal system, remind us of some forms of Hemipedina, as, for instance, *Hemipedina* **Guerangeri** Cott. et Trig., figured in *Pl. XXII. f. 5*, Échin. de Sarthe. The actinal opening is small, with sharp cuts for the passage of long, narrow gills (*Pl. III. f. 2*). The spines are long, moderately stout, as long as the diameter of the test, longitudinally striated, resembling the spines of some species of Hemipedina figured by Wright. The pores are arranged in vertical connected arcs, of from three to four pairs. There are two rows of perforate primary tubercles in the ambulacral area, decreasing rapidly in size towards apex, and placed close together (*Pl. III. f. 3*). They are considerably smaller than those of the interambulacral area. There are one or two small imperforate tubercles at the base of the larger ones. The poriferous zone is broad and well defined, spreading slightly at actinostome (*Pl. III. f. 2*).

The perforate interambulacral tubercles are arranged in two primary rows, separated from the poriferous zone by a row of small imperforate tubercles (*Pl. III. f. 3*), with two or three similar irregular rows between the larger tubercles in the median interambulacral zone. The pedicellariæ of test, near the abactinal pole, have very large, broad, open arcs (*Pl. III. f. 6*), when full grown, resembling those of Echinus proper; the young pedicellariæ (*Pl. III. f. 7*) are more compact. The plates of the abactinal system are large (*Pl. III. f. 1*), with straight sides; the genital are heptagonal, carrying five to six small tubercles, and as many still smaller ones. The ocular plates are pentagonal, with a large ocular pore surrounded by an arc of small tubercles. The plates covering the large anal system are very numerous and minute. The anus is situated in the very centre of the anal system. The teeth resemble those of Arbacia. The buccal membrane is strengthened round the mouth, close to the teeth, by ten large plates (*Pl. III. f. 2*), (perforated for buccal tentacles,) occupying nearly the whole membrane, with eight to ten very much smaller ones between the large plates and test. The color of the large spines, in alcohol, is of a dull yellowish-green, while the smaller spines, as well as test and abactinal plates, have a more yellowish tint.

Diameter.	Height.	Abactinal System.
11.2	4.8	6.4

From 138 to 270 fathoms.

ECHINUS.

Echinus Rond. 1554. De Piscib. (Linn.). (emend.)

This genus, as limited by Desor, contained only species more or less globular, having comparatively small tubercles, smooth, imperforate, of nearly equal size on the two areas, forming but two principal vertical rows upon the coronal plates upon both areas, the other tubercles being smaller and irregularly arranged. Actinostome small, with but slight cuts. Buccal membrane bare, with only the ten buccal shields. Spines comparatively stout, frequently attaining a considerable size, in some of the species equalling the test in diameter. Pores arranged in arcs of three. Jaws comparatively weak, auricles slender.

Lütken has first thrown doubt upon the validity of this genus, and is inclined to consider the species of Psammechinus also as true Echini. If we were to found this genus simply upon the presence or absence of the plates upon the buccal membrane, his objections would be well founded. It may be objected that we must take into account the facies of the tubercles, the close arrangement of the miliaries and secondaries contrasted with the sparse and regularly placed primary rows of the true Echini, and the totally different structure of the abactinal system, which would seem to justify us in considering Psammechinus as a subdivision, certainly ranking as a subgenus of Echinus proper; yet in Echinus sphaera we find the young so closely resembling the typical Psammechinus that we plainly see that the objections to Lütken's proposition are not based upon solid ground.

Echinus gracilis

! *Echinus* **gracilis** A. Agass. 1869. Bull. M. C. Z. I., No. 9.

Pl. VI^a. f. 6; Pl. VII. f. 1–6.

This species holds an intermediate position between E. **Flemingii** Ball and E. **melo** Lam., to both of which it is allied. Like the former, it is subject to great variations in the ratio of the longitudinal and vertical diameter of the test. The primary tubercles are larger than those of E. melo, but smaller than those of E. Flemingii. The spines in the proportion they bear to test are similar to those of E. melo. The general pattern of coloration is the same, consisting of bands of green made up of irregularly shaped lozenges running in vertical rows, diminishing in intensity towards actinostome, the

intermediate spaces forming brilliant white or straw-colored bands. In one of these white bands is placed the poriferous zone, and each primary row of tubercles is placed in a similar band at the junction of the points of the green lozenges. Thus the test is divided into twenty bands alternately green and white; the poriferous zones, and two principal rows of tubercles being separated by these dark green lozenges, giving the test a most graceful pattern of coloration. The abactinal system is compact and circular; the shape of the genital plates is a pointed pentagon somewhat as in E. melo, while in Flemingii they are heptagonal. The madreporic body is reduced to a narrow band across the genital plate. The anal system is made up of a large number of small plates. The ten large plates of the buccal membrane are quadrangular with rounded corners, carrying stout pedicellariæ similar to those of E. melo. The position and general arrangement of the tubercles is similar to E. melo; the large tubercle is placed in the centre of the interambulacral plate, which carries in addition short horizontal rows of two or three minute tubercles, the row near the horizontal suture being the most prominent. In the ambulacral zone the main tubercle has a similar position; the small tubercles are placed close to the median suture, and form irregular vertical rows. Two kinds of pedicellariæ are scattered over the whole surface of the test, supported upon distant miliaries, both in the ambulacral and interambulacral areas. The short-stemmed, thick-headed ones are similar to those of E. melo. The long-stemmed have a triangular, sharp elongate head at the extremity of a very slender stem, with wide arched openings. The distance between the milled ring and the articulating surface of the shaft of the spine is greater than in either of the allied species of Echinus.

Diameter.	Height.	Actinal System.	Abactinal System.	No. of Interamb. Plates.
65.8	69.5	21.5	11.7	28
42.4	57.9	15.3	12.	24
64.2	67.	17.	12.5	25
37.2	34.1	12.	8.7	19
10.1	5.0	5.	2.5	10
12.	17.	5.1	4.2	12

In younger specimens the smaller tubercles of the interambulacral spaces form irregular vertical lines, two on each plate; the miliaries are less numerous, the anal plates larger and fewer in number, and the white bands of the poriferous zones better marked; the ten buccal plates are thickly studded with stout pedicellariæ.

In still younger specimens, measuring from $10^{mm.}$ to $15^{mm.}$, the elegant

markings of the older specimens are scarcely laid out even towards the abactinal region, where in the older specimens they are most distinct. The main vertical rows of the primary tubercles, both of the ambulacral and interambulacral, are very prominent; miliaries are almost absent, the anal system of the youngest specimen being covered by five plates, one of which occupied nearly the whole of the anal system. This species attains a considerable size; specimens are in our collection measuring 65.8 in diameter, and another 78mm. in height, exceeding somewhat the transverse diameter.

In Echinus, as in Toxopneustes, we find in the younger stages (*Pl. VII. f. 2, 4*) the same unbroken vertical arrangement of the pores, taking next a vertically arched form, still connected, and then assuming the arrangement of the adult. In these genera the anal system is at first covered by one plate, and undergoes changes similar to those of Strongylocentrotus, by the addition of four smaller plates (*Pl. VII. f. 1*), and so on (*Pl. VII. f. 3, 5, 6*), the original subanal plate retaining long a greater prominence. The miliaries are formed in these genera as well as Strongylocentrotus by radiating ridges arising from the base of the primary tubercles, forming a sort of star (*Pl. VII. f. 2*); then they swell at the distal extremity, forming a set of club-shaped spokes round the main tubercle; these are little by little separated from it, and become independent elliptical tubercles at first, and then miliaries or secondary tubercles. The ten large buccal plates of the actinal membrane are the first to appear. Small plates (in genera in which they are found in the adult) are next formed between them and the teeth, while afterwards they cover the whole membrane, as in Toxopneustes and Trigonocidaris,—a mode of growth of the actinal buccal plates totally different from that of the buccal plates of Cidaris, where new plates are added next to the coronal plates of the test, carrying the poriferous zone along with them.

In young specimens of Psammechinus microtuberculatus we have a structure similar to that of the young of Echinus proper (*Pl. VIII. f. 19–21*). The poriferous zone is vertical, there being no tendency as yet, in specimens measuring 5mm. in diameter, for pores to form arcs of three pairs; the tubercles are already closely crowded together, but no more than is the case in young specimens of E. sphaera of the same size, where we see, perhaps better than in any other species, the impossibility of separating Psammechinus as usually understood from Echinus proper as has been maintained by Dr. Lütken. In Hipponoë the lateral spreading of the pores takes place very rapidly

(see *Pl. VIII. f. 29*), while in Psammechinus the pores frequently remain vertical so long that we might be tempted, as has been frequently the case in allied fossil species, to retain the adult in the genus Arbacia AGASS. non GRAY, from the impossibility of stating confidently whether the pores were arranged in arcs of three pairs or not.

Echinus norvegicus

! *Echinus* **norvegicus** DÜB. o. KOREN, 1844. Skand. Echin.

Pl. VI^a. f. 4.

Test flat, slightly conical, depressed. Abactinal system prominent, compact, raised above level of test. Anal system small, genital plates large, with large genital openings, and prominent secondary tubercles on part near anal edge. Two principal vertical rows of primary tubercles in ambulacral and interambulacral space, with two shorter vertical rows of larger secondaries extending from actinostome to ambitus, in interambulacral space, on each side of primary row, and from ten to twelve secondaries on each plate, with intermediate spaces filled by miliaries. Ambulacral space narrow, plates well covered by secondary and miliary tubercles except along median line near abactinal region where bare as well as in the interambulacral median space. Mouth rather larger than in other species of Echinus of its size. E. norvegicus, like E. elegans, is flattened below, with the actinostome somewhat depressed. Primary spines straw-colored, long, sharp, tapering; secondaries, same color, attaining about one half the diameter of the test.

The variations of species of true Echinus are very considerable, the species recognized are by no means discriminated with the accuracy which is required, and the differences of opinion prevailing respecting the number of species of this genus, as is readily seen by examining the Synonymic Lists of various writers, show how much remains to be done. The remarkable uniformity in appearance of the specimens of the allied species of E. elegans, norvegicus, Flemingii, melo, and the absence of complete series of different sizes of the different forms, seems to make it impossible at present to characterize these species with great accuracy; and I give with great hesitancy such differences as I have noticed which appear constant, stating at the same time that E. Flemingii, E. elegans, and E. norvegicus may yet turn out identical species, as well as E. gracilis and E. melo, though the material at command in the different Museums does not at present justify such a position.

I had not, when writing the Preliminary Report, seen a good series of

Echinus norvegicus and referred the single small specimen to Echinus Flemingii. It is a young Echinus norvegicus of which the Museum now possesses a good set of specimens, thanks to Professors Thomson and Lovén and Dr. Lütken.

The younger Sars has separated as distinct from E. norvegicus, under the name of E. rarispinus, specimens which are in my opinion only very globular E. norvegicus; under the name of E. depressus, large flattened specimens with remarkably large and stout spines of an umber color, tipped with pink, equalling in length more than half the diameter of the test, with a somewhat larger anal system, more like that of E. elegans, and in which the secondaries are arranged in circles round the primaries upon the somewhat higher coronal plates. The series of specimens dredged by the Porcupine Expedition plainly shows this to be a modification of the typical E. norvegicus, which previously had been known mainly from small specimens, very few of them measuring more than one to one and a half inches in diameter having been found previously.

TOXOPNEUSTES.

Toxopneustes Agass. 1836. Prod. (non Agass. Des. 1846).

Ecnini with test more or less conical, tubercles of uniform size, arranged in several vertical rows in interambulacral and ambulacral spaces. Poriferous zone broad, pores arranged in inclined arcs of three pairs, in the larger species forming three irregular vertical rows resembling the arrangement of Hipponoë. The actinostome is large, the cuts are deep, the buccal membrane thickly plated with large imbricating plates. Spines short, moderately stout.

My attention was first called to the affinity of Boletia and Lytechinus from a comparison of young Boletia pileolus and Boletia rosea with young specimens of Lytechinus; the former had all the features of Lytechinus, except of the plated buccal membrane. A closer examination of the subject shows that no positive character can be drawn to distinguish the two genera except the presence of the plated buccal membrane of Lytechinus. The peculiar pedicellariæ so finely developed in Boletia also occur in Lytechinus, but are much less numerous and also much smaller. The structure of the abactinal and actinal systems, the general structure of the ambulacral

system is the same in the two genera. In old specimens of Boletia we find, during the growth of the poriferous zone, that new plates are frequently added at any point of the poriferous zone, thus introducing an element of irregularity in the trigeminal arrangement, giving a greater preponderance to the apparent vertical arrangement of the pores which is not found in Lytechinus, though in young Boletia maculata, and up to the largest size, the mode of growth of the poriferous zone is the same as in the typical Lytechinus, and in this species of Boletia the general features of Lytechinus are retained; unfortunately the buccal membrane of B. maculata is not preserved in any of the specimens examined, and I am unable to show any correlation between these characters. For the present it does not seem advisable to maintain Lytechinus even as a subgenus of (Boletia) Toxopneustes, until we know something more of the Boletia maculata.

Toxopneustes variegatus

! *Echinus variegatus* (**Lamk.**) 1816. A. s. Vert.
! *Toxopneustes variegatus* A. Agass. 1872. Rev. Ech., Pt. I.

Pl. II. f. 5, 6; Pl. IV^a. f. 4, 5; Pl. VII. f. 7–20.

The tubercles both of the ambulacral and interambulacral areas are arranged in perfectly regular vertical rows, closely packed on lower surfaces in interambulacral area, but one vertical row of large tubercles extending from ambitus to the apex, the one next to the poriferous zone gradually becoming much smaller, while the others, according to the size of the specimens, extend more or less towards the abactinal region, leaving a bare median space on which the granulation of the plate is very fine and compact. The secondaries are far apart and irregularly scattered round the primaries. In the ambulacral space the outer vertical rows alone extend to the abactinal region, the others but a short way above ambitus, leaving a bare median space as in the interambulacral space. The spines vary very much in thickness and coloration. The variety with long, slender spines, with a greenish coloration of test, has been called E. variegatus; specimens with a uniform yellowish or violet tint, having at same time generally blunter, stouter, and shorter spines, have received the name of carolinus and atlanticus. The actinal cuts are moderate; the buccal membrane is completely covered by large, very prominent plates, closely packed together. The depression of the median interambulacral space near apex, so common in Boletia rosea, leaving the ambulacra raised, is frequently found in this species also.

No. Primary Tubercles	Diameter.	Height.	Actin System.	Abactinal System
31	72.	39.9	21.2	11.5
25	59.5	32.3	17.4	11.
22	47.5	25.4	16.1	7.5
22	39.1	23.	15.2	
20	34.2	18.3	13.7	

More abundant material collected by the Thayer Expedition from St. Thomas, Rio Janeiro, and along the whole coast of Brazil by Messrs. Allen and Hartt, by Mr. Bickmore at the Bermudas, and by Mr. Pourtalès, in the Deep-Sea Dredgings of Florida, reduces the number of species of this genus, which had been distinguished by my father and myself, to the original E. variegatus of Lamarck. The extensive series of large specimens brought to the Museum by the Thayer Expedition, collected at every point from Rio as far as St. Thomas, shows an extent of variation which is most surprising, while the young specimens collected by Pourtalès show an equal variability, leaving none of the characters upon which Lytechinus carolinus or Lytechinus atlanticus had been established as sufficiently permanent to warrant their separation from Lytechinus variegatus. Yet, as is generally the case in species of extensive geographical range, we find a few features which seem to characterize the majority of specimens found at different localities, while others again have such combinations of characters as show unmistakably the gradual transition of all the features by which these so-called species have been distinguished. The specimens from South Carolina, Georgia, and the shores of both sides of the peninsula of Florida, as well as Alabama and Louisiana, usually possess slightly stouter spines, a somewhat thicker test, and larger tubercles. Those of West India Islands, as well as the south shore of Cuba, have a thinner test and rather more elongate spines. The specimens from the Bermudas have more closely crowded tubercles and slender spines. In the specimens collected by Mr. Pourtalès at thirty-four fathoms, we find slender spines and the primary tubercles far apart, leaving the test quite bare, when compared to the average of specimens of the same size of various localities. But when we take the series from Brazil, of which we have by far the greatest number, we find all these various characters combined alternately so as to leave no doubt that we have but one species extending from Rio Janeiro along the whole coast of Brazil, to the West India Islands, the shores of the Gulf of Mexico, Cuba, Florida, Georgia, South and North Carolina. Those features which are usually well marked as specific differences — the structure of the scales on the actinal membrane. the pedi-

cellariæ, and the abactinal system — agree in all specimens to a remarkable degree. In the Bulletin of the Museum of Comparative Zoölogy, I separated the genus Lytechinus from Psammechinus to which *Echinus variegatus* (**Lam.**) had been referred on account of the actinal notches, the regular arrangement in vertical rows of the primary tubercles, and the absence of secondary tubercles which fill so large a space on the coronal plates of Psammechinus miliaries, as well as the arrangement of the pores and the structure of the abactinal system; the arrangement of the tubercles of the test being similar to that of Magnosia, from which genus it differs, however, in not having the pores spreading near actinostome, but remaining trigeminate to the extremity of the ambulacra, having a more deeply notched peristome, which is much smaller, in comparison to the diameter of the test. Lütken, about the same time, though a few weeks later, as far as publication is concerned, distinguished this same genus on the same grounds which are given above, and has correctly referred to it, also, E. semituberculatus from the Galapagos Islands; but, as I have shown above, there is no good reason for separating Lytechinus from Boletia, and for not restoring to both these genera their original name of Toxopneustes.

This species has, like the common Echinometra, a great geographical range identical with it, but at the same time has a somewhat more extensive bathymetrical distribution.

Littoral to 34 fathoms.

In the youngest specimen examined, measuring 4.7^{mm} in diameter (*Pl. VII. f. 7*), the arrangement of the pores (*Pl. VIII. f. 8*) differed from that of the adult in being in vertical rows; the abactinal system was still quite imperfectly developed, having by no means the prominence and distinctness it attains in the adult, its structure being well shown already in specimens measuring 18.5$^{mm.}$ in diameter. In this smallest specimen the sutures of the genital plates were indistinct, the ocular plates could barely be distinguished, the whole anal system was covered by a large prominent plate, and on one side of it, next to the left ocular plate, opened the anus; the madreporic body was quite prominent, jutting out like a sponge above its genital plate. Both in the ambulacral and interambulacral areas, the two prominent rows of tubercles of the adult are well marked; there are nine coronal plates; buccal membrane, as in adult, covered with imbricating scales. In specimens somewhat older, there are no important changes, beyond those of the anal system, where the single plate is replaced by five, four other

smaller ones are found on its sides arranged $>^{\circ\circ}_{\circ\circ}$, so that the larger plate occupies the base of the V-shape, and the smaller plates the point where the anus opens (*Pl. VII. f. 10*). This specimen measured 9.1$^{mm.}$, and had eleven coronal plates; the genital plates have become slightly more distinct. It is, however, only in specimens measuring 10$^{mm.}$ in diameter, and having fourteen coronal plates, that the abactinal system becomes more prominent and the sutures well marked. In specimens measuring 11.2$^{mm.}$ in diameter the abactinal system is slightly raised, and numerous small plates of anal system have appeared, completely obscuring the original arrangement of the anal system.

HIPPONOË.

Hipponoë GRAY, 1840. Synops. Cont. Brit. Mus.

Echini of large size, with thin test, tubercles small and numerous, imperforate, not crenulate, arranged in horizontal and somewhat irregular vertical rows, median ambulacral and interambulacral spaces frequently bare. Actinostome small, but deeply notched Poriferous zones broad; pores arranged in three vertical rows, middle row sporadic, exterior ones regularly vertical. Ambulacral areas very broad. Spines short, moderately stout.

In retaining the name **Hipponoë** of GRAY, to which objections will undoubtedly be raised on the ground of Hipponoa having been before used by Audouin, and from the fact of the name alone appearing without further indications of its connection, I am simply carrying out the principle that Hipponoë and Hipponoa are two very different words, and that when specimens are accessible which have served as basis for any systematic work, their results should be accepted, when correct, even when they upset a nomenclature generally recognized.

Hipponoë esculenta

! *Cidaris esculenta* (**Leske**), 1778. Addit. KLEIN.
! *Hipponoë esculenta* A. AGASS. 1872. Rev. Ech., Pt. I.

Pl. VI^a. f. 1–3; Pl. VIII. f. 29.

In large specimens measuring 110$^{mm.}$ we find twelve vertical rows of principal tubercles in the interambulacral space; the arrangement of the tubercles on each plate is more in horizontal rows; towards the median line,

which, from the ambitus to the abactinal pole, is more or less bare, the coronal plates are covered by miliaries. The third vertical row, counting from the poriferous zone, is the most prominent one, this and the adjacent one internally (towards median line) being the only ones to reach the abactinal system. The tubercles, as a general thing, are very uniform in size, except in specimens where much of the median line is bare, when the contrast between the main row (the third) and the other is more marked, more like primary and secondary. On the lower surface, both of ambulacral and interambulacral spaces, the tubercles are very uniform in size and closely packed in concentric rows round actinostome as centre. The median ambulacral space is filled by five more or less distinct vertical rows, quite marked at ambitus, central row indefinite, exterior being more prominent, also tending to arrangement in horizontal rows; the vertical lines of pores are separated by irregularly arranged vertical rows of secondary tubercles forming from two to three vertical lines.

Abactinal system well marked, madreporic body larger than others. Three ocular plates excluded from large anal system covered by a comparatively small number of plates of nearly uniform size, very few smaller ones immediately round anus, each plate carrying but one or two small secondary tubercles and few miliaries, the genital ring having but few secondary tubercles; near anal system they are more numerous, but also sparsely scattered over the rest of the genital and ocular plates. The actinal opening is small, with deep cuts; membrane covered by minute plates irregularly scattered, not closely crowded. Spines short, comparatively stout. Color of spine whitish or yellowish, test generally brownish, the median line frequently (interambulacral space) colored a beautiful violet. Young specimens in which the median interambulacral and ambulacral space are comparatively very bare have been described by Girard as **Heliechinus**. The central vertical line of pores of the poriferous zone is slightly nearer the inner line, though frequently almost in middle.

No. Primary Tubercles.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Width Poriferous Zone.	Spine.
21	28.5	15.2	5.8	3.	10.	2.9	4.6
23	45.4	29.3	8.1	3.7	13.1	3.8	7.5
34	88.2	49.	12.	7.	23.2	7.8	12.
38	118.	67.	19.	10.9	26.2	9.1	13.

Heliechinus Gouldii of Girard (*Pl. VI^a. f. 3*), of which the original is in the Museum collection, is nothing but a young Hipponoë esculenta. In

spite of the apparent polyporous arrangement of the pores in three vertical rows, we find, on analysis of the plates, that, as Dr. Lütken has shown, there are but three pairs of pores for each ambulacral plate. With advancing age the arcs of these pairs of pores, at first quite distinct in young specimens, and still to be seen in the very uppermost part of the poriferous zone, gradually become more and more horizontal, and finally form three regularly vertical rows, due simply to lateral crowding and not to additional plates, as is readily seen in *Pl. VIII. f. 29*, the upper part of the poriferous zone of a young Hipponoë esculenta, showing the gradual changes taking place, from a vertical arrangement, as in Echinus, to the characteristic poriferous zone of Hipponoë.

Littoral to 10 fathoms.

When alive the color of the spines of Hipponoë esculenta is white or straw-colored, a darker color at the base, or brownish-yellow. The median interambulacral space is spotted with black, the color of the heads of the innumerable pedicellariæ, scattered thickly over the whole of that part of the test. The ambulacral suckers are white at tip, gradually passing to yellow, and finally the basal part of sucker is of a dark-brown color. So that when suckers are fully expanded, the tentacles form lighter bands, intermediate between the black bands of the median interambulacral spaces. The buccal membrane is reddish-brown as well as yellow, and the suckers near the actinostome are of the same color.

CLYPEASTRIDAE.

Suborder **Clypeastridae** AGASS. 1836. Prod. Mon. Rad.

EUCLYPEASTRIDAE.

Family **Euclypeastridae** HAECKEL, 1866. Generelle Morph.

FIBULARINA.

Subfamily **Fibularina** GRAY, 1855. Cat. Rec. Ech. (emend.)

ECHINOCYAMUS.

Echinocyamus VAN PHEL. 1774. Brief.

Small flattened Sea-urchins with a thick test. The ambulacra are very imperfectly petaloid, poriferous zones diverging or parallel, pores disconnected. The horizontal sutures of the ambulacral plates extending to the actinostome, pierced with a large number of pores, the pores most numerous above the ambitus. The interior of test has simple radiating partitions extending towards the central actinostome. The supports of the jaws (auricles) very tall and broad. Ambulacra broader than the interambulacra; tubercles of uniform size, extending over apical rosette; pores of madreporic body frequently as large as genital or ocular openings. Spines short, slender; anus inframarginal, situated near actinostome; genital pores four in number, small, indistinct; ocular pores large.

Echinocyamus pusillus

Spatagus pusillus MÜLL. 1776. Prod. Zool. Dan.
! *Echinocyamus pusillus* GRAY, 1825. Ann. Phil.

Pl. XI^e. f. 3; Pl. XIII. f. 1–8.

The species of this genus present great difficulties; their small size, the usually imperfect condition of their preservation, the great variation in the shape of the test, and the differences due to growth, make it extremely difficult to eliminate the special conditions of the specimens from the specific differences; as far as I can judge from the material at my command, many of the species have been based upon totally inadequate characters. The specimens

collected in Florida by Pourtalès were determined in the Preliminary Report as young of (Stolonoclypus) Clypeaster, basing my identification upon the peculiar structure of the ambulacral area. We find that the poriferous zone extends beyond the imperfect petals (*Pl. XIII. f. 6*), as a series of pores in the sutures of the ambulacral plates (*Pl. XIII. f. 2, 3*), across the whole width, from the base of the petals to the actinostome (*Pl. XIII. f. 4*), — a character which had not previously been noticed in Echinocyamus, though it was known in the flat species of Clypeaster from Müller's researches. Subsequently, however, on opening these small Echini, I found the characteristic radiating partitions of Echinocyamus, while specimens of Clypeaster subdepressus showed already the concentric pillars developed near the edge of test, as in *Pl. XIII. f. 11*, the small, high arched teeth of Echinocyamus also greatly contrasting with the large flat teeth of Clypeaster, although at first sight in these small specimens it is frequently difficult, without an internal examination, to decide to which genus specimens belong, — a difficulty which soon disappears when the ambulacral rosette is better developed. On comparing these specimens from Florida carefully with Norwegian specimens of Echinocyamus pusillus I could detect no specific differences between them, and found that E. pusillus had, like our supposed young Clypeaster, the same peculiar structure of the poriferous zone. The outline varies from a pyriform to an elliptical one, more or less swollen, concave on actinal side; the pores are joined by very slight furrows; the ambulacra three times as broad as the interambulacra; the apical system large, though not distinct; in large specimens from six to seven pairs of pores to each petal. Anal system small, composed of four to five triangular plates. The spines of the lower part of test are more slender than those above ambitus, being frequently subulate when exposed to much wear. The color of spines of specimens when alive is greenish, frequently yellowish, or a mixture of the two.

Littoral to 325 fathoms.

ECHINANTHIDAE.

Subfamily **Echinanthidae** A. AGASS.

CLYPEASTER.

Clypeaster LAMK. 1816. An. s. Vert. (emend.)

The flat Clypeastroids are readily enough distinguished externally from their allies, yet their generic distinction would often be difficult, if not impossible, with such species as Echinanthus testudinarius from Australia, were it not for the flatter character of actinal surface, the less sunken mouth, and the better defined ambulacral grooves radiating from the actinostome. But the interior at once furnishes us a set of characters of great importance, in the absence of the double ambulacral chamber, and the slender needle-like pillars which replace the massive columns of the true Echinanthus. Actinal surface flat; actinostome sunken in a cavity of small extent, and well circumscribed, while in the other genus the cavity commences quite gradually.

Clypeaster subdepressus

! *Echinanthus* **subdepressus** GRAY, 1825. Ann. Phil.
! *Clypeaster subdepressus* AGASS. 1836. Prod.

Pl. XI^b; Pl. XI^c. f. 1, 2; Pl. XII^d. f. 4; Pl. XIII. f. 10–18.

The only specific differences thus far noticed in the species of this genus are the character of the tuberculation, the position of the genital openings, and the comparative width of the median ambulacral space in the petals. The outline is elliptical, with slightly re-entering sides in the median interambulacral spaces. The greatest breadth is usually opposite the termination of the posterior pair of ambulacra; but in specimens in which the edge of the test becomes swollen, the greatest breadth is opposite the anterior pair of ambulacra (*Pl. XI^c. f. 1, 2*). The test usually is nearly flat from the margin to the extremity of the ambulacral petals, then it commences to rise, and rises quite suddenly, arching regularly to the abactinal pole. The odd petal and the posterior pair have the same width of median ambulacral space; in the anterior pair this median space is narrower; they are also much shorter than other petals, though the posterior pair are longer than the odd anterior one. The genital openings are small, placed close to the madreporic body. The general outline of the petals is somewhat lanceolate, but this varies

greatly; the poriferous zone is narrow; the tubercles are small, uniform over the upper part of test; the miliaries are large, so that granulation appears quite homogeneous, the same granulation extending over the madreporic body. The spines over the whole of test are fine, short; the same generally on the lower surface, where, although the tubercles are slightly larger than on upper part of test, it is only immediately round the cavity where the mouth is placed that we find larger tubercles carrying longer spines. The ambulacral furrows are well marked from edge of test to actinostome, extending along the upper part of the test in the median and lateral sutures to the extremity of the rosette. The small anal system is at a short distance from the edge of the test on the lower side.

The color is yellowish-green from above, — when alive, somewhat lighter on lower side, where the sutures of the plates are a brilliant yellow, — the poriferous zone is a dark carmine, the edge of the test and the internal part of each plate of upper part of test is pinkish, surrounded by a yellowish border. The height of the test varies extremely; we find all possible stages between a highly arched test where ambulacral petals are placed, suddenly tapering, and a thin edge scarcely rising towards apex, so that the general aspect is that of an extremely flat Laganum when cursorily examined. A similar form of Clypeaster humilis is represented in the Pacific Ocean by the **Scutella latissima** of Lamarck, which is nothing but an extremely attenuated Clypeaster humilis. Agassiz distinctly says it is allied to C. scutiformis. This is an error, as it undoubtedly is a flat Clypeaster humile, although by mistake it was subsequently referred to Laganum in the Catalogue Raisonné. The variations in our common species are figured in the Plates; a specimen figured on *Pl. XII[d]. f. 4* is the young of the flat type, while on *Pl. XIII. f. 16–18* we have the young of the specimen with a thick swollen edge, high central test, to which I had given in the Preliminary Report the name of S. Ravenelli. A remarkably fine series of this form from Georgia, in the Museum of Liverpool, shows that the characters upon which I had distinguished it from C. subdepressus are only of secondary importance. The internal structure of edge of test is of course very different in the specimens with a thin edge or a swollen margin; in one case the pillars are few and broad, in the other they form quite a series of concentric lamellæ over a good portion of the interior of the test (*Pl. XII[e]. f. 4*).

The presence of a true Laganum in the West Indies has been often men-

tioned by various writers on Echinoderms, but it has invariably been presumed to be founded upon mistaken localities (Peronella decagonalis) or a confusion with young specimens of Clypeaster subdepressus. Mr. Pourtalès has dredged, from a depth of thirty-four fathoms, a small Clypeaster subdepressus of about two inches in length, which has the facies of a Laganum (*Pl. XIII. f. 16–18*) to such an extent that it would pass for one without an examination of the internal structure. The outline is pentagonal, with rounded corners; the pentagon is equilateral, and more regular than in any species of Laganum, the central part of the test rising abruptly from the extremity of the ambulacral rosette, which is not swollen. The petals are opened at the extremity. In this young specimen the lower surface is covered with spines only upon the interambulacral and a part of the ambulacral area, leaving broad, bare bands of the ambulacral areas colored light yellow, giving this specimen a striking appearance. The tubercles of the upper part of the test are quite small, closely crowded together; they increase in size in the interambulacral spaces of the lower surface. The color of the spines is greenish-yellow. The test has a thick, rounded edge, and it may be that specimens of this shape have been collected by those who have referred to the presence of a Laganum in the West India Islands. Hupé speaks of Laganum latissimum as found on the coast of Brazil. His specimen is nothing but the extremely flat variety of this species, of which I have also seen specimens from Cuba in the collection of Mr. R. Arango.

Lütken has given an excellent figure of young of this species (Bidrag. til. Kundskab om Echiniderne, *Pl. II. f. 2*). Mr. Pourtalès has dredged young specimens, one younger (in this youngest specimen the ambulacral rosette was already developed, *Pl. XIII. f. 10*) than the one figured by Lütken, and the other slightly older. The specimens can at once be recognized as young of C. subdepressus by their short ambulacral rosette and their sunken actinostomes. The comparatively thick rounded edge of these young specimens gives them a striking resemblance to Laganum. In the oldest of these, and in one measuring only a trifle over $51^{mm.}$ in longitudinal diameter, collected at Charleston, we have already the general elongated outline of the adult, but the edge of the test is much thinner and the ambulacral rosette more closed than in the adult. The tubercles are scattered uniformly over the test, and we do not find, as in the younger specimens, along the edge of the test, larger tubercles in five or six irregular horizontal rows, giving to

the edge of the test of these young specimens a striking appearance (*Pl. XIII. f. 14*). We find frequently on the edge of the test of small specimens the glassy tubercles which are so characteristic of Echinoneus, but they do not appear to be constantly present, and furnish no additional clew as to their function. The great development which the pores of the ambulacral furrows take on the upper part of the test in small specimens is shown in *Pl. XIII. f. 12;* in young specimens the pores of the furrows are limited to the narrow line of the vertical and horizontal sutures of the plates, both on the lower and upper part of the test.

Littoral, — 34 fathoms.

Ant. Diam.	Diam. trans.	Height.	Length Post. Amb	Width Median Petal.	Width Porifer. Zone	Distance of Genital Pores.	Length Ant. Amb.
127	141	23.	44	12.	6.5	5.9	44.8
121	144	23.	38	14.	5.	5.	36.5
94	115	15.3	33	9.	3.8	3.1	26.
48	58	7.	4	4.1	2.		13.

The development of flat Clypeastroids of the type of Clyp. subdepressus is most instructive, tending to show that, in connection with the development of the Scutellidae hereafter described, we must probably introduce a complete reform among the genera recognized as Lenita, Scutellina, Runa, and other minute Echinoids, which may eventually prove to be nothing but the young of other Clypeastroids, such as Mellita, Scutella, Laganum, Clypeaster, Encope, and the like; but the want of sufficient material prevents me from entering into this comparison more in detail. Though we know now, from what I shall show below, that the Scutellidae pass through phases which cannot be distinguished from Moulinsia, Fibularia, Runa, Scutellina, and the Clypeastroids proper pass through a stage of growth similar to Echinocyamus. For similar reasons I am inclined to consider Fibularia as the early stage of some Clypeastroid. The absence of partitions in some species, I think, can easily be accounted for, as they are developed only later. We have a species of Fibularia from the Sandwich Islands, in which there are no partitions when very small, while in the adult these partitions are most rudimentary. Greater material than I possess is necessary to elucidate the affinity of the genus, which certainly has all the features of immature Clypeastroids.

Among the Clypeastroids, as well as among the regular Echini and Spatangoids, a large number of fossil genera have been discriminated which are based upon characters of no permanent value; differences which are not even specific among recent Echini, where we have had an opportunity of examining large series of various ages, having been so exaggerated as to become

of generic importance. This tendency is, however, not confined to the palæontologists alone, for recent writers on Echini, and myself among the number, have gone on subdividing genera till each species bids fair, if not to stand in a genus, certainly to occupy the dignified position of a subgenus. A glance at the material here brought together concerning a few species shows how far we have been going in the wrong direction, and I trust that, for certain groups at least, I have been able to show what direction we must give to our examinations of species to have them yield valuable results.

ECHINANTHUS.

Echinanthus Breyn. 1732. Schedias. (emend.)

Test thick, more or less elliptical or pentagonal. Ambulacral petals broad, often swollen, and limited by wide poriferous zones. Five genital pores, actinostome pentagonal, deeply sunken. Anal opening small, infra-marginal. Teeth placed vertically at extremity of jaws, each of which is supported upon two auricles. The interior is filled by pillars rising from the lower to upper floors; they are continuations of the double floors of the ambulacral and interambulacral chambers, so characteristic of the true Echinanthus, extending from mouth to apex. Johannes Müller, in his Bau d. Echinodermen, was the first to show the radical difference that existed in the internal structure of the flat and convex Clypeaster.

Müller has attempted to show that the madreporic body in the regular Echini determined the true position of the axis in the irregular Echini. In the figures he has given of the abactinal system of a number of species of irregular Echini, he has invariably found that it was the right anterior genital plate which was connected with the madreporic body, or the left posterior; and because we have Echinometrae in which the madreporic body is found either on the right or left of the imaginary longitudinal axis, he argues that it must be one of these posterior plates which is invariably the one to give us the position of the axis, and that it is not placing the irregular Echini in a homologous position with the other regular Echini, where the anus gives us the longitudinal diameter without any chance of error, to place the irregular Echini with the madreporic body in the symmetrical rear, with an ambulacrum opposite, as in the regular Echini. The madreporic body in the Scutellidae and Clypeastridae occupies the whole of the *central part;* it is regular in outline, usually star-shaped, and is not connected in any way

with the genital openings, which open in the interambulacral plates, its position would seem to show that in the irregular Echini, where the anal system is no longer enclosed by the abactinal system, the madreporic body can open anywhere, and become connected with either genital plate, as in the Spatangoids, either right anterior or right posterior, or several of them, including the left posterior, thus depriving it of the value which it has in defining the bearing of the axis of the regular Echini, where its position is fixed, while it is not fixed in the irregular Echini (*isolated in the Clypeastroids*, and may be connected with any one of the genital plates in the irregular Echini), where we find other features to guide us in placing correctly the axis of the animal.

Echinanthus rosaceus

! **Clypeaster** *rosaceus* LAMK. 1816. An. s. Vert.
! *Echinanthus rosaceus* GRAY, 1825. Ann. Phil.

Pl. XI^c.; XI^d. f. 1, 2; XI^f. f. 1–18; XIII. f. 9.

The characters by which most of the different species of Echinanthus have been separated thus far are totally inadequate. The majority of the large number of fossil species from the tertiaries have been distinguished on variations of the height, breadth, outline, the more or less open ambulacral petals, broader or narrower petals, — characters which the accompanying measurements of a series of specimens from Florida show to be found in any set of specimens from the same locality. The outline of this species is more or less elliptical, with convex posterior, lateral interambulacra convex. The test is usually moderately convex, varying in height from half to a third the length of the longitudinal diameter. The ambulacral petals occupy the greater part of the abactinal portion of the test, the madreporic body is central, pentagonal, crowded with small tubercles, the intervening space riddled with holes. The ocular plates joined to it are elliptical; the ocular openings large. The genital openings are large, opening in the median interambulacral space at some distance from the madreporic body. The median ambulacral space of ambulacral petals is broad, more than twice as broad as the poriferous zone, the furrows of which are distant, of uniform breadth for a considerable distance, and then diminishing rapidly towards the distal extremity, and more gradually towards the abactinal pole. The tubercles of upper part of test are remarkably uniform in size, sunken uniform miliaries completely filling the intervening space. The tubercles are more

closely set in the median part of the ambulacral petals than upon rest of test. This median part is frequently quite swollen, rising far above the general level of the test, so that the poriferous zone is regularly sloping from the edge of the zone to the interior row of pores; there the test rises suddenly, and is regularly arched over the remainder of the median ambulacral space. On the lower side, in old specimens, the mouth is deeply sunken, the cavity in which it is placed forming quite abruptly at about two thirds the distance from the edge of the test. The ambulacral furrows are very plainly defined, increasing rapidly in width a short distance from the edge of the test, and retaining a uniform breadth to the mouth. The tubercles of the lower side are much larger than those of upper part of test, placed closer, more deeply sunken, the miliaries surrounding them not so distinct. The anus is placed close to the edge of the test. The spines are short, of uniform size over the whole upper part of the test with the exception of the poriferous zone, where the average of the spines separating the ambulacral furrows is somewhat more slender. Those of the lower part of test are considerably stouter and longer than those of the upper part of the test.

The posterior ambulacral petals are the longest; the odd ambulacral one is slightly shorter, the anterior pair are considerably shorter; the median space of the odd petal is narrower than that of the other ambulacra, which are of uniform breadth.

The color of this species when alive is, from above, a beautiful reddish-brown; the median ambulacral region enclosed by the poriferous zone is more yellowish; the poriferous zone, of a darker reddish color, is a background upon which the flesh-colored lobed tentacles of the petaloid ambulacra are projected (*Pl. XV. f. 17, 18*). The whole upper part of test is also covered with minute flesh-colored water-tubes, capable of considerable expansion, passing through the small pores which riddle the whole of the test of these double-walled Clypeastroids.

Littoral to 5 fathoms.

Distance between Genital Pores.	Trans. Diam.	Long. Diam.	Height.	Length Post. Petals.	Width Porif. Zone.	Interpor. Median Post. Amb. Petal.	Interpor. Median Odd Ant. Ambul.	Length Odd Ant. Petal.
	38.	48.	13.	13.5	2.	5.4	5.	12.
	58.	71.	29.5	21.	3.	9.	8.	19.
	71.	97.	36.8	33.	4.1	15.3	12.5	29.1
7.3	92.	114.9	34.5	39.	5.6	17.	15.	34.
10.	102 5	124.5	60.	55.	5.5	21.	19.5	47.5
	86.	133.1	53.5	50.	6.	20.	19.	37.9
10.5	112.3	137.5	53.	53.2	7.5	20.5	17.2	41.

It is quite remarkable that of a species so common as this, only one young, small enough to show any very striking difference from the adult, should have been collected, while of nearly all the more common species complete series of all sizes were obtained.

This specimen is figured, natural size, on *Pl. XI^f. f. 1.* It is quite flat, the actinal surface is concave, but the test is not yet swollen; in fact, the edge of the test is only somewhat stouter than in some specimens of Clypeaster subdepressus. The rosette is much smaller, with a dark median ambulacral space, forming a prominent star, from the apical system; the sutures of all the plates are marked by similar dark bands, in both cases formed by minute spines closely crowded together. The primary spines are comparatively prominent, and are figured on *Pl. XI^f. f. 14.* They resemble already closely those of the adult. Younger stages are represented on *Pl. XI^f. f. 12, 13*, the latter being still attached to the test, while the spine (*f. 12*) has a distinct articulating surface. Over the greater part of the upper and lower part of the test are found pedicellariæ (*Pl. XI^f. f. 6, 10*); they are specially numerous in the small triangle at the edge of the test in the median ambulacra (*Pl. XI^f. f. 3*). These pedicellariæ are peculiar; nothing like them has as yet been described, except those of Pourtalesia, which resemble them. They consist (*Pl. XI^f. f. 6*) of a principal shaft, as stout and nearly as large as a primary spine, more transparent, terminating in a cup from which arises a comparatively slender muscle, urn-shaped, terminating in a huge tridactyle head of very remarkable structure, which terminates in three ball jaws; each jaw is broad at base, with from four to five roots, narrows rapidly to form a vertical shaft, terminating in a hollow semi-spherical head, edged with strong teeth (*Pl. XI^f. f. 8, 9*), which magnified appear like a very formidable weapon of attack. *Pl. XI^f. f. 7* is another view of a similar pedicellaria. A second kind is totally unlike this; the head is spherical, made up of thin half-shells articulated upon a long slender muscle and a slender shaft (*Pl. XI^f. f. 10*). The test when denuded (*Pl. XI^f. f. 4*) presents some striking differences from the adult. The primary tubercles are not sunken, but are raised above the general level, are comparatively few in number and large in size. The sutures are well defined by close granulation, the median ambulacral space being specially distinctly banded. In this stage the rosette is already developed (*Pl. XI^f. f. 4*), and from a denuded specimen would present no special points of difference, except in size, from an adult, with the exception of the absence of the genital plates, which are not yet developed, and the

structure of the tubercles in the median ambulacral space. When we examine the suckers coming from these pores, we find them totally unlike those of the adult Echinanthus (*Pl. XV. f. 17, 18*). They are in every particular similar to those of the regular Echini, short, with a prominent well-marked sucker, as seen in *Pl. XV. f. 2*, which represents a portion of the petaloid rosette, while the character of the gill-like suckers of the rosette of the adult is seen in *Pl. XV. f. 17*. Each primary sucker is surrounded in the adult by small slender suckers, not differing from those found in young. The long sucker is lobed on both sides for half its outer length, and is pointed (*Pl. XV. f. 18*). The pores, discovered by Müller in Clypeaster over the whole surface of the test, are already well developed in young specimens (*Pl. XV. f. 16* represents a part of an ambulacral plate of the specimen figured in *Pl. XV. f. 15*). These pores in young specimens carry regular tentacles with suckers, as is shown in *Pl. XV. f. 3*, representing the edge of the test of the young specimen (*Pl. XV. f. 1*) crowded with ambulacral suckers and pedicellariæ. The internal structure of Echinanthus is early developed (*Pl. XV. f. 15*), specimens of the size of *Pl. XIII. f. 9* have already the commencement of the double floor on the edge of the test, and the pillars which separate the ambulacral system from the digestive cavity arise from the floor in sharp, numerous pillars. The changes the interior passes through correspond to those which Encope goes through, where the ambulacra in young stages are not isolated, resembling at one time those of Mellita, but afterwards the cellular structure of Encope completely isolates them; in Echinanthus the double partition early makes its appearance, though for a time the ambulacra are connected with the digestive cavity, resembling the permanent condition of Clypeaster proper; but at no time do we find in Echinanthus the peculiar arrangement of the ambulacral pores of the lower side in the sutures of the plates so prominent and striking a feature of Echinocyamus (*Pl. XIII. f. 2, 3*) and of Clypeaster proper (*Pl. XV. f. 25*).

Numerous pigment cells, specially closely packed in the abactinal part of the median interambulacral space, indicate the commencement of the brilliant reddish-brown coloration so well developed in the adult.

SCUTELLIDAE.

Family **Scutellidae** AGASS. 1841. Mon. Scut. (emend.)

(SCUTELLA.) ECHINARACHNIUS.

Echinarachnius LESKE 1778. KLEIN Add.

Outline circular, test thick; ambulacral petals large, very distinct, open at extremity. Ambulacral furrows sending ramifications out only once near marginal extremity. Mouth central, anus marginal or rather supra-marginal. This genus differs externally from Scutella merely by the position of the anus and the mode of ramification of the ambulacral furrows of the actinal surface, — the median furrow, like that of Laganum, being preserved to the edge of the disk, — and it would perhaps be natural to consider it simply as a subgenus of Scutella, as proposed by Martens. An examination of the interior shows that it has the same arrangement of pillars as Dendraster and Scaphechinus. The mere eccentricity of the apex and the slightly different mode of branching in Dendraster do not entitle it to rank even as a subgenus of Scutella; in Echinarachnius, Dendraster, and Scaphechinus the pillars of the interior are more or less concentric with the edge (*Pl. XI^d. f. 4, 5*), while in Scutella they recall more the stellate arrangement of Mellita. The ambulacral notches of the posterior extremity of Scutella are more or less present in all the genera, so that externally Scaphechinus and Dendraster do not differ from Scutella, the position of the anus being of no value, while internally they show a somewhat different arrangement of the pillars of the edge of the test. For this reason I am inclined to consider Echinarachnius as a subgenus of Scutella; with it Dendraster and Scaphechinus will be merged as mere sections.

The jaws are high, supported upon feeble auricles, lobed in the centre; the teeth are not enamelled at the tip; the edges of the triangular base of the jaws form at their junction a prominent projection, formed of elliptical or circular cells, rising far above the level of the jaws, instead of the lamellar structure of the edge of the jaw existing in Clypeaster, Mellita, and Encope.

Echinarachnius parma

! **Scutella parma** LAM. 1816. An. s. Vert.
! *Echinarachnius parma* GRAY, 1825. An. Phil.

Pl. XI^d. f. 4, 5; Pl. XI^e. f. 4, 5; Pl. XII. f. 1–13.

As the measurements of the accompanying specimens of this species show, the variations in the outline, both from above and in profile, as well as the shape of the petals, are considerable. The outline from above may be either nearly circular or somewhat pointed anteriorly, or decidedly truncated posteriorly, with deep indentations for the anus and in the median ambulacral spaces. The profile may be regularly sloping from a nearly central apical system, with a thin edge of test, or we may have a thick edge of test, and an arching central part of the test from the outer edge of the petals. The position of the apex is also sometimes somewhat eccentric posteriorly, showing that this character alone cannot be of generic value, as had been taken for granted in Dendraster. The apical system is well marked, but differs considerably in specimens of the same size; the rosette is generally open at the extremity in flat specimens, while in more arched ones the petals have a decided tendency to converge at the outer end; the poriferous zone is narrow, not more than from one quarter to one fifth the width of the ambulacra. The marginal ramifications of the ambulacral furrows are frequently quite indistinct in older specimens. The tubercles are closely surrounded by miliaries, covering the whole upper part of the test, including the apical system, with a fine homogeneous granulation. On the lower surface near the actinostome the tubercles are distant; they become, however, closely packed at the commencement of the ramifications of the ambulacral furrows, although there is no miliary granulation on the lower surface so characteristic of the upper part of the test. The spines of the lower surface are larger, longer, and of variable length, those covering the opening of the actinostome are the largest, while the spines of the upper surface are shorter, and of uniform size. The color when alive is a beautiful crimson-carmine, tending to greenish, or of intermediate shades; lower surface of the same color; ambulacral furrows darker.

The range of this species is quite astonishing, and its association on the Asiatic coast with a second well-marked species has undoubtedly caused a great deal of confusion, in addition to the presence of Arachnoides, which, when covered by spines, might readily pass as either of the species of true Echinarachnius. I am unable, upon examination of the originals, to dis-

tinguish the species established by Michelin and Gray, based upon slight local differences, such as the outline of the test from above or in profile, the more or less open petaloid ambulacra, the distinctness of the branches of the ambulacral furrows, which are all features subject to great variation in specimens from the same locality. The length of the petals is very variable, in some specimens not extending beyond half-way from apex to margin, while in others they reach fully two thirds of the distance. There are two principal branches of the ambulacral furrows, commencing from two thirds the distance of the mouth to the edge of the test.

Littoral to 40 fathoms.

Height.	Lat. Diam	Anal Diam.	Length Ant Amb.	Width Med. Inter Porif. Amb.
11.	73.	71.	20.	5.1
13.2	62.9	61.	20.1	8.
7.1	55.3	52.	15.2	4.7
9.	51.5	49 2	14.	3.1
10.5	46 3	46.	15.	5.9

Young specimens of Echinarachnius parma, measuring from 2.1$^{mm.}$ to 6.2$^{mm.}$ in diameter, are readily found in the stomach of our cod. The outline of the youngest specimen observed is elliptical (*Pl. XII. f. 1*). The test is high, arched, resembling somewhat a Cassidulus from the position of the anus (*Pl. XII. f. 3*), and an Echinometra from the vertical rows of large tubercles, one for each ambulacral and interambulacral plate, forming regularly decreasing rows from the apex to the mouth. The lower surface is nearly flat, the actinostome is large, pentagonal (*Pl. XII. f. 2*), being fully one third the diameter of the test across the opening. There are but slight traces here and there of miliaries; the tubercles are so closely crowded that it is impossible, beyond the presence of five pairs of pores, one pair for each ambulacrum, to detect any further trace of the ambulacral pores, although it is easy to identify the ambulacral rows. The vent is placed a short distance above the ambitus (*Pl. XII. f. 3*), no trace of the poriferous zone could be seen near the mouth. The rotules are present in shape of a peculiar spine, which is most prominent in specimens measuring about 4.$^{mm.}$ in longitudinal diameter. In a somewhat older specimen the difference of outline is very striking; it is pear-shaped (*Pl. XII. f. 4*), the blunt end being the posterior; the test is still considerably arched, but has become a good deal flattened when compared to the previous stage. We find also the commencement of the difference in the arrangement of the ambulacral and interambulacral plates, due to the different rate of growth of the two areas. The mouth is

comparatively much smaller, the lower surface has become much flattened, the mouth being sunk, and edges of the test raised. There are quite distinct ambulacral pores, two for each side of the odd ambulacrum, and two and three on each side of the other ambulacra. The pairs of pores are pierced between the plates, and are not connected by furrows. Each plate (ambulacral and interambulacral) of the test carries as yet but one large primary tubercle; the rest of the plate is thickly crowded with miliaries. In a somewhat more advanced stage there was a marked difference in size between the upper pairs of pores, forming an extremely rudimentary rosette (*Pl. XII. f. 5*) of independent pairs of pores not confluent and not joined by furrows, additional pores, pierced through the plates, extending towards the ambitus in continuation of the poriferous zone. The larger pores simply radiate fanlike from the apex; there are four pairs in the odd ambulacrum, three and five in the anterior pair, and four and five in the posterior ambulacra. The miliaries of the plates of test surrounding the main tubercle are larger, and the sutures of the plates more distinctly brought out than in the previous stage. The position of the anus is nearer the ambitus, and when seen from the lower side (*Pl. XII. f. 6*), the young Echinarachnius has the same undulating concavity so characteristic of Pygaster and allied genera. The outline of this specimen was also somewhat less pear-shaped, and flatter. In an older specimen, measuring about 5.1$^{mm.}$ in length (*Pl. XII. f. 9*), the test had become quite flattened, the mouth was slightly sunken below the raised edge of the ambitus, the outline more pentagonal, the vent placed nearer the edge, and we have the first appearance of pores arranged so as to form a distinct rosette, connected by furrows in the part of the rosette nearest the middle. As in the preceding stage, there are additional pairs of pores pierced between the ambulacral plates extending towards the ambitus in continuation of the rosette. Each plate now carries from three to six primary tubercles, according to its size, thickly crowded round with miliaries. The anal opening is closed by a single plate (*Pl. XII. f. 11*); the madreporic body is quite distinct, and very minute pores can be traced in the indistinct ambulacral furrows of the lower side. In specimens measuring 6.$^{mm.}$ the rosette is more prominent (*Pl. XII. f. 10*), the pores being all connected by furrows; the plates of the test are uniformly covered by primary and miliary tubercles, the sutures of the plates are less distinct, and four small additional anal plates have appeared (*Pl. XII. f. 12*) at the marginal edge of the anal opening. In still larger specimens, measuring

about 15.mm. in diameter, the ambulacral rosette has all the features of the adult (*Pl. XII. f. 13*), the grooves uniting the pores are deep, the madreporic body is fully developed, the tubercles are uniformly distributed, the vent closed by six plates (*Pl. XII. f. 12*), the first plate being still by far the largest, — at this stage the difference in the rate of growth between the ambulacral and interambulacral plates becomes quite as striking as in the corresponding stages of Encope. There seems to be no ratio between the number of ambulacral and interambulacral plates, as the older the specimen the greater seems to be the number of ambulacral plates in comparison with the interambulacral plates; when measuring 15.mm. to 16.mm. in diameter, the young Echinarachnius has the general outline of larger specimens, and except its size has, as far as I can see, no further distinguishing features.

MELLITA.

Mellita KLEIN, 1734. Nat. Disp. Ech.

Test exceedingly flat. Ambulacral petals closed, remarkably well defined, five or six elongated lunules in the prolongation of the ambulacral petals; when five are present the odd anterior ambulacral one is wanting, the posterior lunule is situated in the interambulacral space. The ambulacral grooves of the actinal surface are very ramified and undulating. Pillars, in the interambulacral areas, separate the buccal from the digestive cavity. The tubercles of the interambulacra of the lower side are very large, comparatively, between the ambulacral grooves, and small adjoining them. The spines corresponding to the different sizes of tubercles are either long and tapering or short and club-shaped, while larger flat-shaped spines surround the lunules on the upper side. The spines of the upper surface of test are all club-shaped, those edging the lunules more or less spathiform; those of the ambulacral furrows and its branches are curved, and those of the large tubercles of the lower surface straight and elongate. Four genital openings; madreporic body occupying central apical part of test. The anus is at the proximal extremity of the interambulacral lunule, close to the mouth; outline of test circular, truncated posteriorly.

Mellita sexforis

Echinodiscus **sexiesperforatus** LESKE, 1778. KLEIN, Add.
! *Mellita sexforis* A. AGASS. 1872. Rev. Ech. Pt. I.

Pl. XI. f. 1–12; Pl. XI^a. f. 3.

Five ambulacral lunules and one posterior interambulacral one. The apex and the mouth are central, or nearly so, while in the pentaphorous species of Mellita they are quite eccentric. The ambulacral lunules are of the same size, narrow, elongate, while the odd posterior lunule is usually somewhat smaller than the others. The test in all the specimens examined slopes regularly from the apex towards the edge. The outline is more or less circular or pentagonal, but slightly truncated posteriorly. The ambulacral petals are all of the same size, comparatively small, not reaching half-way to the edge of test from the apex. The median ambulacral space, included between the poriferous zones, is as broad as each zone; genital openings distant from apex. The coronal plates of upper part of test are all more or less convex.

The ambulacral furrows ramify more at the extremity near the edge of the test, on each side of the lunules, than in the other species, leaving but a very narrow median interambulacral space not covered by furrows. The large tubercles of the lower surface are consequently fewer in number; they are, at the same time, more uniform in size where they occur; the rest of the lower surface of the test is covered by fine granulation of smaller tubercles near the poriferous furrows. The difference in size between the spines of the two surfaces is slight, their arrangement is the same, there are but few comparatively large spines immediately round the mouth, the whole lower surface being covered by silk-like spines not clavate, like those of the upper part of the test. The color when alive is slightly yellowish, ranging through all the shades of a dirty yellow to a light olive-green. The bathymetrical range of this species is quite extensive (littoral – 270 fathoms), though the geographical range, as far as we know it, is not great, being confined to the West Indies and to the Bermudas.

Young specimens of Mellita sexforis, measuring 2.4^{mm} in diameter (*Pl. XI. f. 1*), are almost circular, with a thickened raised edge as in Laganum, and as yet have no lunules visible from the abactinal side. The rosette is simply a series of radiating pores, three and two in each poriferous zone, for each ambulacrum, extending but a short distance from the apex, having the simple structure of the poriferous zone of non-conjugated pores of Echinocyamus. The ambulacral and interambulacral plates are

of the same size, hexagonal, forming twenty equal zones (*Pl. XI. f. 1*), carrying but a single large tubercle in the centre of each plate; seen from below the surface is deeply concave (*Pl. XI. f. 2*), the mouth much larger in proportion to the test than in adult specimens, and we see forming from this side the posterior interambulacral lunule as a deep pit, at one extremity of which is placed the anus near the mouth, about one third the distance from the edge of the test, as is seen in *Pl. XI. f. 6*, representing the posterior lunule of a specimen somewhat older; the rotulæ are already well developed in specimens of this size (*Pl. XI. f. 5*).

The outline in a subsequent stage becomes slightly pear-shaped (*Pl. XI. f. 3*), the plates elongate; the lunule pierces through to the abactinal side; the rosette is still made up of radiating pores, consisting of five to six pairs of pores for each poriferous zone. The ambulacral area is now slightly narrower than the interambulacral zones, though the plates carry as yet but a single primary tubercle. Seen from below (*Pl. XI. f. 4*), we find rudimentary phyllodes made up of a few of the small pores, which eventually extend in the ambulacral furrows to the edge of the test, but are now restricted to a small number clustered round the mouth (*Pl. XI. f. 4*), entirely similar to those of older specimens, as seen in *Pl. XI. f. 20*, though restricted in extent. When the posterior lunule has become a small round opening (*Pl. XI. f. 7*), encroaching upon the plates of the posterior interambulacral area, which extends as a very faint lobe beyond the outline of the test, the rosette becomes slightly pentaloid. There are now from two to five tubercles on each plate (*Pl. XI. f. 7*); the plates are quite elongate, having lost their hexagonal outline; the lower surface is flat, and on the lower side (*Pl. XI. f. 8*) the ambulacra have broadened very rapidly, the interambulacra forming narrow bands carrying larger tubercles between the ambulacral zones, showing already in a very marked manner the difference, so prominent in older specimens, in the character of the ambulacral and interambulacral areas of the actinal side. The edge of the test is still quite thickened (*Pl. XI. f. 7*), and it is only when the young Mellita has attained somewhat less than half an inch in diameter that the ambulacral lunules appear as pits, seen at first from the lower side only, and gradually forcing their way through the test. The posterior interambulacral lunule increases rapidly in size; the lunule and the groove in which the anus is placed become somewhat separated, being simply a depression in the continuation of the lunule. After the appearance of the lunules as slight pits, which develop unequally

(*Pl. XI. f. 10*), not appearing simultaneously, the changes are limited to the increase in size of the lunules (*Pl. XI. f. 11*), and of the poriferous ambulacral zone on the lower side; the outline and general facies, with the exception of the larger size of the tubercles, being that of the adult (*Pl. XI. f. 12*).

Contrary to what was to be expected from analogy, we find in Mellita Stokesii, so closely allied to Mellita sexforis, the lunules developed as cuts along the periphery, exactly as in Encope, and in the two other species of Mellita, so that the mode of development of the lunules does not seem to have any great physiological value, whether formed by the resorption of the test in the centre of the plates, or by a retardation of their growth at the edge of the test; those species which are most closely allied having diametrically opposite modes of development of the lunules. In fact, the mode of development of Encope and of Mellita testudinata (and M. longifissa) is far more closely allied than that of the two species of Mellita of the types of sexforis and Stokesii.

Mellita testudinata

! **Mellita testudinata** Klein, 1734. Nat. Disp. Echin.

Pl. XI. f. 13–22; Pl. XII^a.; Pl. XII^c. f. 1, 2.

Four lateral ambulacral lunules, in continuation of the median line of ambulacra, and one posterior interambulacral one; outline more or less rounded anteriorly, truncated posteriorly, greatest width usually across the lateral posterior interambulacral space; the organic apex is slightly eccentric anteriorly, the test sloping gradually towards the posterior edge, but curved towards the anterior edge, which is usually thicker, though we find frequently specimens in which the slope is the same towards both edges; the lunules are all narrow, elongate, the interambulacral one being the largest. The petals are of nearly uniform size, the odd and anterior pair slightly shorter than the posterior pair. Each poriferous zone is broader than the enclosed median ambulacral space; the poriferous furrows are separated by a single row of tubercles very regularly arranged in a line parallel to the furrows. The tubercles covering the upper surface of the test are extremely uniform in size (except those on the edge of the lunules); they are closely packed, and separated by ridges of minute miliary tubercles. The large tubercles which cover the interambulacral space of the lower side have no regular arrangement, any more than those of the upper part of the test; they are small near the edge of the test, and closely crowded, but

gradually increase in size and become more widely separated, especially near the actinostome from a distance of one quarter of the radius, where they are quite distant. The ambulacral furrows, sending out a principal branch on each side of the median ambulacral space, send out short processes over the whole lower surface, and longer ones near the edge of the test; they diminish considerably in number and distinctness upon the interambulacral spaces, especially the posterior space. The median ambulacral zone carries large tubercles, but they disappear near the branches of the poriferous zones, leaving a considerable distance on each side of them apparently bare, but covered in reality with very minute tubercles carrying diminutive spines. The arrangement of the spines on the lower side in the two species of Mellita is peculiar; the large spines of the anterior interambulacral spaces are directed outward, those of the posterior interambulacra are turned inwards. On the upper part of the test the spines all turn towards the periphery. The color when alive is a greenish-blue.

The general character of the changes undergone by Mellita sexforis, as far as they relate to the transformations of the ambulacral rosette, the growth of the tubercles, the changes in the proportions of the relative breadth of the ambulacral and interambulacral zones, is identical in Mellita testudinata and M. longifissa. What is remarkable in Mellita testudinata is that the mode of formation of the ambulacral lunules is not identical with that of M. sexforis. The interambulacral lunule alone is developed from a depression formed on the lower surface pushing its way through the test, while the ambulacral lunules are the result of the closing in of notches appearing on the edge of the test, which remain open until the young Mellita has attained a considerable size, — three quarters of an inch and sometimes more; long after the arrangement of the plates, the shape of the rosette, the size of the tubercles, and the extent of the poriferous zone on the lower surface have the character of the adult.

The smallest specimens of Mellita observed, measuring about 3.6^{mm} in diameter, are nearly circular; they have at this stage but a single lunule, the posterior interambulacral one, scarcely perceptible from above, but from the lower side well seen as a deep conical pit pushing its way gradually more and more towards the abactinal side, and becoming larger and larger when seen from that side with increasing age; when it has attained a diameter of about $8.^{mm.}$, the centre of the ambulacral edge of the test becomes slightly indented, — the first trace of the ambulacral lunules

(*Pl. XI. f. 13*). The posterior ambulacral lunules (notches) are the first to be developed, the young Mellita having at this stage (excluding the posterior interambulacral lunule) somewhat the shape of a diminutive Echinodiscus, or Encope Michelini, and as the cuts increase in depth with advancing age (*Pl. XI. f. 19*) resemble in a remarkable degree a small Encope grandis. The commencement of the closing process of the notches is shown in drawings of M. longifissa (*Pl. XI. f. 24, 25*), while in *f. 26, 27*, of the same Plate, the lunules are completely closed.

The large series collected by the Thayer Expedition along the whole coast of Brazil shows that this species has a wide geographical range, and is liable to great variations, indicating that the characters which have been described as separating M. quinquefora and M. testudinata have no permanent value.

Littoral to 7 fathoms.

ENCOPE.

Encope Agass. 1840. Cat. Syst. Ectyp.

Contains species of considerable size; actinal surface flat, abactinal more or less regularly arched; always having in the prolongation of the ambulacral petals either lunules or indentations, which vary extremely according to age, and in different individuals of the same species. There are five genital openings, while there are only four in Mellita. The ambulacral petals are very unequal in size, the posterior pair usually larger than the anterior ones. Ambulacral furrows greatly ramified. The main difference between this genus and Mellita consists in the continuous calcareous partition which separates the buccal from the digestive cavity, in place of the disconnected pillars of Mellita. Outline elliptical, truncated posteriorly. In addition, we have in Encope a horizontal floor separating the buccal cavity from the upper part of the test, in which the ambulacral system is confined, while in Mellita the ambulacral petals open directly into the main cavity above the buccal orifice.

Encope emarginata

Echinodiscus **emarginatus** LESKE, 1778. KL. Add.
! *Encope emarginata* AGASS. 1841. Mon Scut.

Pl. XII. f. 14–24; Pl. XII^b. f. 1–3; Pl. XII^d. f. 2–3.

As the accompanying measurements show, it is difficult to define the outline of this species, its variations including all possible forms between a more or less pentagonal outline with the deep cuts (lunules) at the angles of the pentagon, and a subcircular outline anteriorly, retaining only one side of the pentagon posteriorly. Seen from above, denuded of spines, the whole test is covered by remarkably uniform tubercles closely packed with extremely diminutive miliaries, the same granulation extending over the ambulacra, both the poriferous zone and the median part of the rosette; only on the edge of the lunules do we find somewhat larger tubercles. As in other Scutellidae, the median interambulacral spaces are covered by larger tubercles, as well as the rest of the lower surface, except in the proximity of the ambulacral furrows and their branches, which form broad avenues covered by small miliaries. In the typical E. emarginata the lunules are more or less elliptical, and usually their edges at least touch, if they are not completely closed; the odd interambulacral lunule is nearly twice as long as any of the others; the edge of the test in such specimens is thin, and the outline in profile is gradually sloping from the vertex to the ambitus. The vertex is eccentric anteriorly, and corresponds usually also with the apex; but it is not unfrequent that the anterior edge of the posterior lunule is slightly higher, especially if the lip of the lunule is well developed, as in the case of what has been called Encope oblonga, where the lunules are completely closed, and the edge of the test and of the lunules is thick, the outline being at the same time somewhat circular. When the lunules remain wide open, and the general outline of the test is pentagonal, it has received the name of E. Valenciennesii, but there are no features by which it can be separated specifically; though there is a species on the west coast of America having very much the same general outline (E. grandis), which has, however, such remarkable internal structure that there are excellent grounds for maintaining that species.

In specimens measuring 13.mm. in diameter, the ambulacra are not yet separated from the digestive cavity by the complete wall of spongy calcareous mass so prominent in old specimens. In these and young specimens simple pillars connect at first the two floors, as in Mellita and Echinodiscus.

Pl. XII^b. f. 2 shows the extent to which the ambulacra are isolated from the remainder of the digestive cavity in fully grown specimens. The jaws are quite small (*Pl. XII^b. f. 3*), and the calcareous cellular work connecting the two floors leaves a comparatively small space for the winding of the alimentary canal, which becomes quite narrow and small by the time it reaches the anal opening.

Among the specimens dredged from considerable depth were a number of Encope emarginata of various sizes, from half an inch in longitudinal diameter to an inch. These, in addition to a large series of young of the same species sent from Desterro by Dr. Fritz Müller, present some interesting structural points, and have also, not unexpectedly, however, led to the conclusion that Moulinsia was nothing but a young Encope. Dr. Lütken, in speaking of the chance of young Encope being a Moulinsia, seemed to consider the scalloped edge as a most distinguishing feature. The same feature is also quite prominent in young Mellita, but they are always more circular, and do not assume the elongated form which is so characteristic of Moulinsia. This scalloped edge is not most prominent in the youngest specimens; it is most striking when they are from 6.^{mm} to 8.^{mm} in diameter, previous to the appearance of the lunules on the dorsal side, when, as I think, the figures will show plainly they have all the appearance of Moulinsa (*Pl. XII. f. 14, 15.*). There are some points in the structure of the young specimens of the size figured by Lütken, to which it may be worth while calling attention. Lütken has noticed that there was a striking difference in Mellita and Encope in the modes of formation of the ambulacral lunules. In Encope they are formed by the closing in of notches made by the prolongation of the plates, which often remain open during the whole life, while in Mellita (M. sexforis) the ambulacral lunules are formed by pits in the test itself. I have noticed that these pits (lunules) appear at first on the lower surface, and little by little force their way through the test (see Mellita sexforis); the posterior interambulacral lunule in Mellita is formed in the same way, and the same is the case in Encope, where I have observed it in the youngest Encope (a specimen from Desterro, sent by Dr. Fritz Müller) in the condition of a Moulinsia, when the lunule was a very marked pit on the lower surface alone (*Pl. XII. f. 15*), not yet having forced its way through the test to the dorsal side, which had a smooth unbroken posterior interambulacral dorsal area (*Pl. XII. f. 14*). The anus opens directly in the centripetal extremity of the lunule, while in the adult the lunule and the

anal opening are separate, the latter being placed at a considerable distance from it toward the mouth. As the specimens become older there is a tendency to separate, the anus being placed in a groove which is a shallow continuation of the lunule, approaching more and more the mouth, till, in specimens measuring 37.$^{mm.}$ in diameter, the anus is completely separated from the lunules (see *Pl. XII. f. 18, 21, 23, 25*). The shifting position of the anus depending upon entirely individual circumstances, shows that its position cannot be used as a specific character. The youngest Encope I have had occasion to examine shows already traces of the two posterior ambulacral notches (*Pl. XII. f. 14, 15*), but they are so slight that they would most likely be overlooked, especially in specimens somewhat more advanced, when the scalloping is more prominent (as in the figures of Moulinsia of Agassiz in his Monographie des Scutelles), in fact, the cuts of the edges being fully as deep as the notches. These divide the edge of the test into twenty well-marked scallops, the ambitus is elliptical, the apex central, and in this condition the ambulacral and interambulacral plates both diminish gradually in size towards the centre, forming twenty sharply defined ridges, the sutures between the plates running to the apex from the edge of the test being well marked by the absence of granulation. Each ambulacral and interambulacral plate carries from one to two, or at most (near ambitus) three, primary tubercles, the rest of the plate being covered by miliaries. There is no ambulacral rosette, but two pairs of pores; one pair, between adjoining ambulacral plates, extend in each poriferous zone from the apex to the ambitus, there being in the present stage only as many ambulacral as interambulacral plates (*Pl. XII. f. 14*), seven from ambitus to apex. There is a faint trace, even at this early stage, of a madreporic body, but no genital openings are as yet formed. The pairs of pores are not yet connected by a furrow, but are simple holes. The furrows formed by the sutures of the plates are not as deeply cut on the lower surface, those of the median ambulacrum being most prominent; the position of the poriferous furrows is indicated by minute pores irregularly scattered, while towards the mouth at the base of the furrows the pores are quite large, forming almost an imitation phyllode. The rotules, on each side of which start the lines of pores, are already apparent. The lower surface is concave, the edge being slightly raised; the outline seen in profile is somewhat more convex than in older Encope, but the difference bears no comparison to the difference noticed in young Echinarachnius.

In older specimens, where the posterior interambulacral lunule has just forced its way to the dorsal portion of the test (*Pl. XII. f. 17*), the abactinal part of the ambulacra is petaloid, the last two pairs of pores alone are not connected by furrows, and are pierced between two adjoining ambulacral plates, while the other pairs, fourteen in number, are joined by furrows. These fourteen plates correspond to four interambulacral plates, showing a different rate of growth between the plates of the interambulacral and ambulacral series. The sutures between the various ambulacral plates have become obliterated, there are a large number of tubercles on each plate, and the general aspect of the upper surface begins to resemble more closely that of the adult. The madreporic body is well developed, no genital openings yet. The pores on the lower surface are particularly numerous round the actinostome, forming ten points, somewhat like phyllodes (*Pl. XII. f. 18*), having their origin on each side of the rotules. In a somewhat more advanced stage the lines of pores are connected at their base, and fork at a short distance from the mouth (*Pl. XII. f. 21*). The interambulacral plates on the lower surface are covered by larger tubercles than the others, making five narrow zones, in contrast with the ambulacral region, where the tubercles are very minute.

The outline of the young stages of Encope (*Pl. XII. f. 20–24*) before the closing of the lunules, while they are still mere indentations, recalls strongly the post-pliocene form Monophora, and some of the other species of Encope found on the west coast of Florida and the Gulf of California, E Michelini and E. grandis.

Dr. Lütken, in his discussion of Encope emarginata, has given figures of young Encope after the appearance of the posterior interambulacral lunule.

The madreporic body is large, quite markedly stelliform, the ocular plates often rising as sharp ends from its sides, the genital openings are large and placed at a considerable distance from the centre of the madreporic body within the median interambulacral space. The posterior pair of ambulacral petals are longer than the others, the odd petal somewhat shorter, and the anterior pair of ambulacra intermediate in length. The poriferous zone has about the same width in all the petals, but the median ambulacral space of the posterior ambulacra is quite narrow compared to the others, the poriferous zone being broader than this median space in the posterior ambulacra. The posterior lunule extends to within one quarter the distance of the mouth from the edge of the test, the anus is placed quite near the mouth

in the commencement of the depression of the lunule. The color when alive is dark olive-green.

The difference in the width of the median ambulacral spaces is scarcely marked in young specimens, as is seen by the measurements; the posterior lunule also is frequently enclosed by the posterior ambulacra in large specimens, while in small specimens it is frequently entirely outside the extremity of the petals. The ambulacral petals become more and more different in length with increasing size; the difference of the median ambulacral spaces is but little perceptible in young specimens.

Height.	Trans. Diam.	Ant. Diam.	Post. Pair Ambul.	Ant. Pair Amb.	Interpor. Post. Amb.	Interpor Ant. Amb	Width Porif. Zone Ant. Amb.	Post. Lunule.
14.2	115.	122.	34.5	28.	4.	5.8	6.2	29.
13.5	113.	120.	34.	24.9	6.	6.3	6.	31.
13.	99.	98.	26.	19.	4.1	5.9	5.9	24.8
7.	79.8	80.5	20.5	15.5	3.	4.	3.	15.3
5.	62.	61.2	14.	10.	2.	2.9	2.4	11.2
3.4	48.1	45.	10.5	8.	1.8	2.	1.8	7.
3.5	38.	38.	8.	7.5	1.2	1.2	1.2	6.5
16.5	140.	121.	45.	33.	4.		7.5	44.

Littoral — 7 fathoms.

Encope Michelini

! *Encope* **Michelini** AGASS. 1841. Mon. Scut.

Pl. XII^b. f. 4; Pl. XII^c. f. 3, 4; Pl. XII^d. f. 1.

The extensive suite of Encopidae brought home by the Thayer Expedition from different points of Brazil, and more particularly the series of all sizes of Encope emarginata which the Museum owes to the kindness of Dr. Fritz Müller, of Desterro, has satisfied me that Lütken is correct in uniting under one name, that of E. emarginata, most of the nominal species he mentions (E. Valenciennesii, subclausa, oblonga, E. quinqueloba), to which we would add the name given by Belval, *E.* **Ghiesbrechtii.** Yet I cannot agree with him in referring to the same species Encope Michelini, in which the position of the apex is totally different from that of any of the other species referred to E. emarginata, as is readily seen by the excellent profile given in Agassiz, Mon. d. Scut., *Pl. VI^a. f. 10.* Nor can I agree with him in referring E. grandis to Encope emarginata, a species found in the Gulf of California, and Encope Agassizii, identical with it. There is a second species also found on the West Coast, which Verrill has described as *E.* **occidentalis**, and which is identical with *Encope tetrapora* AG. non GMEL. From a careful comparison of specimens of E. cyclopora, micropora, and perspectiva, there is no doubt that these

are only nominal species, all identical with E. occidentalis; and as the name "micropora" seems to be the most appropriate, besides being the oldest, it would be the best name to retain. A careful statement of the points of difference between E. micropora and E. emarginata will be found in the description of the Panama species, in the general descriptive part of the species.

This species is readily distinguished from E. emarginata by the position of the vertex, which is directly in front of the small posterior lunule, and is not due, as is sometimes the case, to the swelling of the lip of the lunule, but to a rise in the test itself. The outline resembles, at first glance, more that of E. grandis, but it is more pentagonal; the lunules are frequently closed, and when closed become obliterated exteriorly in old specimens; the small size of the posterior interambulacral lunule is striking, scarcely as large as the marginal lunules; the three anterior lunules are frequently mere indentations in the margin, giving to the general outline very much the appearance of Echinodiscus with an interambulacral lunule (*Pl. XII^c. f. 3*). The vertex as well as the mouth is nearly central; the anus is placed about one third the distance from the mouth to the edge of the test. The tubercles are more closely packed than on the upper part of the test of E. emarginata, while the spaces filled with larger tubercles between the bare avenues adjoining the ambulacral furrows of the lower side are narrow, and the tubercles smaller than in the preceding species. It is, however, on examining the interior (*Pl. XII^b. f. 4*), that we are at once struck with the remarkable differences to be noticed between these two species. The size of the jaws, the narrow marginal band connecting the two floors, the great size of the cavity occupied by the alimentary canal, the width of the alimentary canal, and the size of the walls separating its different convolutions, contrast strikingly with the small jaws, the narrow convolutions of the alimentary canal, and the great breadth of the marginal band connecting the upper and lower floors of E. emarginata (*Pl. XII^b. f. 3*).

Height.	Transverse Diam	Long. Diam.	Length Post. Pair Amb.	Length Ant. Pair Amb.	Width Interporif. Post. Amb.	Width Interporif. Ant. Pair Amb.	Length Post. Lunule.	Width Porif. Zone Post. Pair Ambul.
18.	125.	128	50.4	36.2	3.2	5.4	13	7.9
16.8	110.5	106	39.9	31.9	4.2	5.6	16	6.
11.	94.	84	20.5	23.	3.	5.	13	4.

Littoral to 11 fathoms.

PETALOSTICHA.

Suborder **Petalosticha** HAECKEL, 1866. Generelle Morphol. (emend.)

Among Spatangoids proper, the examination of young specimens shows that they undergo great changes in outline during their growth; the posterior part of the test is especially subject to variation, the position of the anus is exceedingly variable in one and the same species, the mouth is not labiate in the young as in the adult, the peripetalous and lateral fascioles do not change in their limits, but the subanal and anal fascioles are liable to great modifications during their growth, and cannot be used as distinguishing features of generic value, while the permanence of the peripetalous and lateral fascioles is of great systematic value. The ambulacral petaloids also are greatly modified with age, generally becoming confluent, while in the young they are remarkably distinct, and the pores not conjugated.

Lovén has already called attention to some of the most striking peculiarities of Spatangus purpureus when young. To show the extreme care which must be taken in our determination of genera among Spatangoids, I have introduced figures of a small Spatangus purpureus (*Pl. XI^f. f. 19–22*), which is remarkable for its globular shape, but particularly interesting on account of the structure of the abactinal part of the ambulacra (*Pl. XI^f. f. 19*). The pores are as yet simple, not conjugate, resembling in every particular the simple pores of young Cassidulidae and of regular Echinidae, no trace as yet being seen of the petaloid structure of this part of the ambulacra. The ambulacra are in this young Spatangus identical in structure with those of Holaster, and of other genera of Ananchytidae.

The Cassiduloid-shaped mouth of young Spatangoids, as well as the existence of several Spatangoids, both fossil and recent, in which the mouth has a similar structure, is a convincing proof of the correctness of uniting Cassiduloids and Spatangoids in the same suborder, though the name given to them by Albin Gras, of "Irregular," is hardly what could be desired.

The great number of Spatangoid genera established upon differences in the subanal fasciole, the existence or absence of the anal branch, the depth of the ambulacral grooves, the confluence or distinctness of the lateral am-

bulacra, all based upon characters subject to great variation during growth, show the necessity of a careful revision of the whole group of Spatangoids, especially of the fossil genera, with the data here furnished, before we can attempt an arrangement of Spatangoids into natural families.

CASSIDULIDAE.

Family **Casidulidae** Agass. 1847. C. R. Ann. Sc. Nat. VII. 147.

ECHINONIDAE.

Subfamily **Echinonidae** Agass. 1847. C. R. Ann. Sc. Nat. VII. 147.

The close structural resemblance between the young of Echinolampadae and Echinonëus shows that Echinonëus has no affinity whatever with the Galeritidae, with which the genus has always been associated, but that it is a true embryonic Cassidulus allied to Echinolampadae and Caratomus, already suggested by Desor to be a true Cassidulus, and not a Galerites. This affinity the examination of young Echinolampadae proves undoubtedly. The removal of Echinonëus, Caratomus, and all the allied edentate forms of Galerites, now reduces the family to one of great homogeneity, and suggests again the question of their affinity to true, regular Echinoids in a more forcible manner than before. We must, however, wait till we find a living representative of Galerites to have the question fully decided. I am inclined, in the mean while, to associate the Galeritidae having teeth with the true Echinoids, and consider them as forming among Echinoids a prophetic type of the Clypeastroids, with which they have many points of resemblance.

This subfamily contains elliptical subovoid Echini, with simple ambulacra and remarkably uniform sunken tubercles; no jaws.

ECHINONËUS.

Echinonëus Van Phel. 1774. **Brief.**

This genus has been very generally placed as a subfamily among the Galeritidae. The embryology of Echinolampas shows conclusively that this association is not natural, and that the view first maintained by Lütken of its Cassiduloid affinity is the correct one. Thus far, Echinonëus is the only

genus of this subfamily, though probably other genera will eventually be associated with it. The Echini forming this genus are not large; the test is thin, ovoid; there are no teeth. The actinostome is central and oblique to the longitudinal axis, has no phyllodes nor bourrelets; the anal system is extremely large, more or less pyriform, situated between the mouth and the posterior extremity. The tubercles are large, numerous, arranged in more or less regular rows, no mammary boss, neither crenulated nor perforate. The ambulacra are simple, extremely narrow, extending unbroken from apex to mouth, the poriferous zone forming a narrow vertical band of simple pairs of pores. The presence of so-called glassy tubercles, not carrying spines, irregularly scattered over the test, is a striking feature of this genus. Abactinal system ill defined, four genital pores, spines short, ambulacral suckers provided with disks as in the regular Echini.

Echinonëus semilunaris

Echinus **semilunaris** Gmel. 1788. Linn., Syst. Nat.
! *Echinonëus semilunaris* Lam. 1816. A. s. V.

Pl. XIV. f. 1–5.

Lütken, like myself, has only been able to recognize one species in the West India Islands. As is well known, the difficulty of distinguishing the species in this genus is very great; the more so, as thus far only tests without spines, and without buccal or anal membranes, from uncertain localities, have been used in the determination of species. The Museum has specimens from Cuba, Hayti, and the West Indies, which I have been unable to distinguish by any characters given as specific by Desor in his Monog. des Galérites. The arrangement of the tubercles and of the glassy tubercles is so different in various parts of the test, and in specimens of different sizes, that it is impossible to separate, with any degree of accuracy, the species recognized by Desor, and which had already, in the Catalogue Raisonné, been considerably reduced in number. Having, fortunately, in the Museum Collection, specimens which, without any doubt, were collected at the Sandwich Islands and the Kingsmills Islands, I am able to give a comparative description of the two species I have been able to identify. This will be the more complete, as in some of the Sandwich Island specimens the anal and buccal membranes are still retained, while M. Pourtalès has collected a living specimen with all its spines at Carysfort Reef. I had, in the Bulletin of the Museum of Comparative Zoölogy, adopted the name of *E.* **elegans** Des. as the only name given to specimens which undoubtedly came from the West Indies. Lütken

has perhaps more properly retained the name *E. semilunaris* Lam., which was adopted by Duchassaing, and which has been given by Desor, with some doubt, to a species collected at Trinidad. I would retain for the species from the Sandwich and Kingsmills Islands the name cyclostomus; to judge from the description of the color given by Desor to his E. serialis, the Sandwich Island species may prove identical with it; this name is scarcely applicable, being based upon an arrangement of the ambulacral tubercles, which is frequently met with in specimens of the two species. As far as I am able to discriminate between the tests of these two species, the Pacific species is remarkable for the narrowness of its poriferous zone (*Pl. XIV. f. 7*), the pores being placed in close contact, separated by a ridge carrying small tubercles, while in the specimens of E. semilunaris the poriferous zone is much broader (*Pl. XIV. f. 3*). It has also (taking the same point of the test in specimens of the same size) larger tubercles, and a greater number of large glassy tubercles (*Pl. XIV. f. 7*), while the miliaries are closely crowded together. In E. semilunaris, on the contrary (*Pl. XIV. f. 3*), the primary tubercles, as well as the glassy tubercles, are proportionally much smaller and farther apart, the miliaries being more numerous. From an examination of the alcoholic specimen from Florida, I could not come to any satisfactory conclusion concerning the function of the glassy tubercles; they are not primary tubercles in the course of growth, as they are fully as large, and the primary tubercles, when young, always appear at first as opaque tubercles. They carry no special spines. On living specimens their function will probably be ascertained. Similar glassy tubercles often appear on the edge of very young Clypeastroids (Clypeaster subdepressus), which disappear in older stages. Desor has given figures of the spines; but, in addition to these, the test is thickly covered with stout pedicellariæ carried upon moderately long peduncles. The tentacles do not differ (*Pl. XIV. f. 2*) (as far as could be judged from this alcoholic specimen, where they were still tolerably expanded) from the tentacles of ordinary regular Echini, having prominent sucking disks. The tentacles retain the same structure from the mouth to the apical system. On the lower surface, especially round the mouth and anal system, the spines are longer and more slender (*Pl. XIV. f. 4*) than on the remaining portions of the test. The anal system will, I think, furnish good characters for the determination of species, if we can judge from the striking differences the arrangement of the plates of the anal system presents in the two thus far examined. In the Pacific species (*Pl. XIV. f. 6*) the anal opening is more

pear-shaped; the anus is placed near the blunt end, surrounded by a number of small plates arranged concentrically round it, and extending as a narrow band of small, slender, elongated plates between the single rows of large plates, extending on each side along the other extremity of the anal system. This row of plates consists of five large plates, diminishing in size from the centre of the row towards either extremity; they carry a few large tubercles bearing spines. In the West India species, on the contrary, the anal system is more pointedly elliptical (*Pl. XIV. f. 5*), the anus being placed almost in the centre, surrounded by a smaller number of small plates radiating from it irregularly. The single outer rows are made up of four plates, leaving a triangular space covered by small plates between them and the anus. The rest of the anal system is covered by much larger polygonal plates than in the Pacific species. The buccal membrane is covered by small quadrangular plates, entirely free from spines, arranged in rows radiating from the mouth, diminishing in size towards the opening of the mouth placed in the centre of the membrane. The absence of teeth is fully confirmed by an examination of this specimen.

Littoral.

NUCLEOLIDAE.

Subfamily **Nucleolidae** Agass., 1847. C. R. Ann. Sc. Nat., VII. p. 147.

ECHINOLAMPAS.

Echinolampas Gray, 1825. Ann. Phil.

Echini more or less ovoid, apical system eccentric. Ambulacral petals elongate, unequal, the pores of the same petals frequently differently developed. Actinal surface slightly concave. Actinostome transverse, elliptical or pentagonal, more or less eccentric. Floscelle tolerably well marked. Bourrelets moderately prominent. Anal system infra-marginal, transverse. Tubercles of very uniform size; difference in size scarcely perceptible between the actinal surface and the rest of the test.

Echinolampas depressa

! *Echinolampas* **depressus** Gray, 1851. Ann. Mag. N. H.

Pl. XVI.

In the first dredging expedition of M. Pourtalès, he brought home fragments of the ambulacral rosette of an Echinolampas, which must, to judge from the size of the fragments, have attained a length of about two inches.

What was striking in these fragments was the distinct continuation of the poriferous zone beyond the ambulacral rosette and beyond the ambitus, a feature which would at once distinguish it from either Echinolampas Hellei or E. oviformis. In the second expedition he dredged from a depth of thirty-five fathoms off the Tortugas a small specimen measuring over an inch in length (*Pl. XVI. f. 17 – 19*). The general outline resembles strikingly that of E. Hellei; it is, however, much more depressed, and differs by the peculiar structure of the ambulacral rosette (*Pl. XVI. f. 21*). Both in the posterior and anterior pairs of ambulacra the rosette is not strictly petaloid; the outer poriferous zones of each of the lateral ambulacra are very irregularly developed. In the posterior pair the anterior poriferous zone (the part forming the rosette) is fully developed to about the point where the rosette usually terminates in the other species of Echinolampadae, while in the inner or posterior poriferous zone the portion where the pores are joined by a groove is not quite half as long as the adjoining poriferous zone. In the anterior lateral pair, the posterior poriferous zone is the short one, and in the odd anterior ambulacrum it is either the left or the right poriferous zone which is the shortest. This same structure also occurs in several fossil species. Unlike the other species of Echinolampas, the outer poriferous zone extends unbroken to the mouth; the two rows of pores are not placed close together; it is always the exterior row of pores which is continued from each zone, and not pairs of pores, as is uniformly represented in all drawings of fossil Echinolampadae. The ambulacral zone also widens between the poriferous zone, as it approaches the ambitus, and as the poriferous zone is sunken and the ambulacral slightly raised, the ambulacra have very much the appearance of the ambulacral zones of Echinonëus. Round the mouth the pores form a very distinct floscelle. What is remarkable in this young Echinolampas is the absence of the peculiar bourrelet (*Pl. XVI. f. 20*) so characteristic of the other genera of Echinolampadae, the only sign we have at present of them being an accumulation of small tubercles closely crowded together, which occupy the interambulacral spaces, and are identical in arrangement with those found on the bourrelet of older Echinolampadae. The peculiar bare space of the actinal interambulacral space so characteristic of some fossil species of Pygorhynchus, is well marked, though in older specimens of Echinolampadae this band nearly disappears, there being but very faint traces of it left. The primary tubercles are by far less numerous in this species than in either the E. Hellei or E. oviformis;

they are not closely crowded, but the secondary tubercles occupy a considerable space round each primary tubercle; this may, however, only be characteristic of the young, as in the fragments of older specimens they are found somewhat more crowded; no spines are found with any of these shells and fragments, and the single whole large specimen had lost its buccal and anal membranes.

The development of Echinolampas depressa has thrown unexpected light upon the affinities of the toothless Galerites and of the Cassidulidae. It shows conclusively that Echinonëus is only a permanent embryonic stage of Echinolampas, thus becoming allied to the Cassidulidae, and that it has nothing in common with the Galerites, as I would limit them, confining them entirely to the group provided with teeth. This reduces the type to a most natural division, and from what we now know of the simple nature of the ambulacra of all Echini in their early stages, I would not give to this feature the significance which it has received, but would be inclined to unite the toothed Galerites with Echinidae proper in the same sub-order, approaching the Clypeastroids by the separation of the anus from the apical system, and retaining the teeth and general symmetrical structure of the regular Echini. I am aware that the great development of Galerites in former geological periods, and the relation of the anus and test, may, on further acquaintance with living representatives, entitle them to rank as a suborder intermediate between the Echini proper and Clypeastroids. Young Echinolampas depressa, measuring a trifle over $4.0^{mm.}$, are elliptical, resembling Echinonëus, with a large transverse elliptical lobed mouth (*Pl. XVI. f. 2*), the anus placed in the truncated posterior extremity above the ambitus. The outline in profile is almost globular (*Pl. XVI. f. 3*), truncated at the posterior extremity, where the anus is placed. Each plate of the narrow ambulacral zone carries a single principal tubercle (*Pl. XVI. f. 4*), surrounded by a circle of miliaries. The pores are arranged in a vertical row of a single line of pores, three or four for each ambulacral plate, extending from the mouth to the apex. The interambulacral plates are elongated horizontally, and carry from one to three principal tubercles, with numerous small miliaries arranged in circles round the primaries, or irregularly scattered (*Pl. XVI. f. 4*). Seen from above, the outline is elliptical (*Pl. XVI. f. 1*), the madreporic body is quite prominent, the large primary perforated tubercles of the interambulacral area increase in size towards the actinostome, where the miliaries are also less numerous. The spines are comparatively long, resembling those of some of the Clypeastroids.

In specimens twice the size of the above the test is less elliptical, more flattened, and the first trace of a rudimentary rosette appears as a short row of double pores extending from the apex (*Pl. XVI. f. 6*), consisting of from eight to nine pairs, only in one of the poriferous zones of each of the lateral pairs of ambulacra — in the anterior zone of the posterior pair and the posterior zone of the anterior pair of ambulacra — the old ambulacrum remains simple. In specimens measuring about 13$^{mm.}$ this rudimentary one-sided rosette has increased in length (*Pl. XVI. f. 7*), and traces of the second row of double pores are seen in the simple zones near the apex. In specimens measuring an inch (*Pl. XVI. f. 21*), these rows have grown to be half as long as the arc of the rosette first formed; the same structure has also extended to the abactinal part of the odd ambulacrum, and the furrow connecting the pores of the petaloid part of the ambulacra (*Pl. XVI. f. 22*) is as well defined as in any old specimen of Echinolampas. The regular elliptical outline so characteristic of the young specimens when seen from above (*Pl. XVI. f. 1*), and the high globular profile, are gradually changed to a more circular and flattened test, passing through a more or less pentagonal outline (*Pl. XVI. f. 8–10*), and at last with the gradually increasing projection of the posterior extremity the test assumes an ovoid outline (*Pl. XVI. f. 17–19*). While these changes are going on, the miliary tubercles increase rapidly in number, forming clusters of small tubercles, embossing the plates of both areas. This is quite a prominent feature in one of the stages (*Pl. XVI. f. 8–10*). With increasing age the primary tubercles become more numerous, and finally appear as a nearly homogeneous granulation, with closely packed miliaries between, in specimens of about an inch (*Pl. XVI. f. 17–19*). The anal system is covered by three large triangular plates, carrying a few tubercles (*Pl. XVI. f. 5, 14*), the anus opening near the edge of the system, in a narrow slit covered by very minute plates. The mouth, as the young increase in size, becomes more and more sunken, losing little by little its prominently lobed outline (*Pl. XVI. f. 2*), and passing from this stage through that of a slightly sunken actinostome, showing no trace whatever of the bourrelets or phyllodes (*Pl. XVI. f. 9*), to the stage represented in *Pl. XVI. f. 18, 20*, when the phyllodes are plainly laid out, and the first trace of the bourrelet appears as accumulations of minute tubercles closely packed together (*Pl. XVI. f. 20*) between the phyllodes. The buccal membrane is covered with minute plates, the mouth opening in the centre of the membrane (*Pl. XVI. f. 2, 9*), as a diminutive slit. When measuring about

half an inch in length (*Pl. XVI. f. 8 – 10*), the young Echinolampas resembles Caratomus to such an extent that this stage was considered for a time a living representative of Caratomus. The larger series collected by Mr. Pourtalès, in his second expedition, showed conclusively the relationship to Echinolampas, and proves the correctness of the step taken by Desor in removing Caratomus and allied genera from the Galeritidae, and placing them among the Cassidulidae, on account of the semipetaloid nature of the apical portion of the ambulacra. Bifurcate pedicellariae with a short stem (*Pl. XVI. f. 15*) and a large transparent head are irregularly scattered over the test; the spines resemble those of Clypeastroids (*Pl. XVI. f. 16*), being short, slender, straight, the secondary spines silk-like. The tentacles, as far as could be ascertained from alcoholic specimens, are provided with a powerful sucking disk; they are covered by dark pigment cells (*Pl. XVI. f. 13*) as long as the specimens retain the aspect of Caratomus. The character of the tentacles does not change in any part of the poriferous zone. They retain their disk even after the petaloid nature of the abactinal part of the ambulacra is fully developed and the pores are joined by a well-defined furrow; so that we have the apparent anomaly of sea-urchins with petaloid ambulacra, yet possessing only tentacles differing in no way from those of the regular Echini. A similar state of things has been shown to exist in the young of Echinanthus rosaceus at an age when the denuded petaloid ambulacra appeared to differ in no wise from those of the adult, carrying well-developed lobed tentacles in the petaloid portion of the ambulacra; yet a young specimen, measuring over an inch, was only provided with tentacles terminating in a powerful sucking disk.

The bare part of the posterior interambulacral area between the anus and the actinostome, often so prominent in the adult, is not apparent in the young, and is formed by minute miliary granulation, encroaching more and more with increasing size upon the larger primary tubercles of the actinal surface. There are no teeth nor signs of auricles in these young, so that we can assume that the genera now associated with Cassidulidae, allied to the Caratomus and the like, were, as well as Echinonëus, edente.

From 35 – 160 fathoms.

NEOLAMPAS.

Neolampas A. Agass. 1869. Bull. M. C. Z., I., No. 9, p. 271.

Test thin; outline pyriform from above, profile regularly arched, posterior extremity truncated, anal opening projecting as a tube; tubercles of uniform size over the whole test, raised above the surface of the test; no ambulacral petals; ambulacral system simple, reduced to single pores between the ambulacral plates, extending from the apex to the actinostome. Floscelle and bourrelets well developed.

Neolampas rostellata

! **Neolampas rostellatus** A. Agass. 1869. Bull. M. C. Z., I., No. 9, p. 271.

Pl. XVII. f. 1–12.

Outline from above resembling Echinolampas (*Pl. XVII. f. 1*), more elongated, three large genital openings, placed closely together, the right or left anterior one atrophied, madreporic body restricted to a narrow ridge separating them. Seen in profile (*Pl. XVII. f. 3*), the test rises gradually from the anterior extremity towards the apical system, attaining its greatest height between it and the posterior extremity; this is sharply truncated anteriorly, as in some species of Catopygus. The lower surface (*Pl. XVII. f. 2*) is concave, undulating; the anal system (*Pl. XVII. f. 4, 5*) is large, elliptical, occupying the whole of the posterior truncated end, somewhat as in Botriopygus, the test being turned in like the finger of a glove, while the anus opens at the end of a long slender tube, projecting well beyond the outline of the test (*Pl. XVII. f. 6*), the anal tube starts from the upper part of the anal membrane, this is covered by small plates (*Pl. XVII. f. 5*), gradually diminishing in size, and eventually firmly soldered together to form the base of the anal tube. Test thin, mouth placed near the anterior extremity, having a well-developed floscelle and prominent bourrelets (*Pl. XVII. f. 9*). The test is covered by minute tubercles of different sizes (*Pl. XVII. f. 8*), not separated into primaries and miliaries, as in Echinolampas. The tubercles are not sunk, but stand out prominently from the test, having a smooth mammillary boss and a rough scrobicular area. The spines are straight, very fine, slightly club-shaped, resembling those of the Scutellidae (*Pl. XVII. f. 10*). There is no ambulacral rosette, so prominent in all the Echinolampadae. From an

external examination alone it would be difficult to trace the course of the ambulacra, but from the interior (*Pl. XVII. f. 11*) we easily see one pore for each ambulacral plate, extending from the floscelle to the apical system, and appearing as minute pores when seen from the outside; through them protrude very slender tentacles showing no trace of disk. In fact, the structure of the whole of the ambulacra is identical with the structure of the part of the ambulacra between the rosette and the mouth in other Echinolampadae. The color of this Sea-urchin is yellowish-green, and I am convinced it is not the young of any other Echinolamp, in spite of its size ($14.7^{mm.}$), owing to the great development of the bourrelets, which in other Echinolampadae appear only after the specific characters are fully formed and the main features of the adult are attained.

There is a peculiar structure of the ambulacra of Cassidulidae which seems to have escaped notice thus far. The rosette is formed by two poriferous zones, each containing two pores joined by a furrow. The poriferous zone, which extends from the petals to the floscelle (mouth), is reduced to its simplest expression, a single pore between two adjoining ambulacral plates; it is only the inner set of pores of the poriferous zone which extends to the mouth in all the ambulacra; the exterior pair does not go beyond the rosette. The buccal membrane is bare, the mouth itself exceedingly minute. The bourrelet between the floscelle is well marked by the crowded tubercles packed as closely as they can be placed. The floscelle is well defined, consisting of large elliptical pores; there are only three of the inner set of pores. I was at first tempted to regard this genus as the young of a new Echinolamp, on account of the absence of the ambulacral rosette. But having found in a young Echinolampas the ambulacral rosette developed before the bourrelets, I take it for granted that this species has the principal specific characters of the adult, unless this genus forms an exception to all other Echini allied to it, as in all young Clypeastroids, Spatangoids, and Echinolamps which I have examined, long before we can tell with certainty to which genus the young Echinoderm is to be referred, such an important character as the ambulacral rosette is already well developed (Encope, Mellita, Echinarachnius), or at any rate more prominent than the remaining portion of the ambulacral system.

From 100 – 125 fathoms.

(CASSIDULUS.) Rhynchopygus.

Rhynchopygus D'Orbig. 1855. Pal. Franç.

Lamarck's genus Cassidulus, as established in 1801, contains in it two distinct types: Cassidulus lapis caneri; the species from the West Indies and Cassidulus Marmimi. This has been separated as a distinct genus, Rhynchopygus, by Desor, with which the recent species of the genus must also be associated, as has been proposed by Lütken. After an examination of a fine series of fossil species of the genus Cassidulus, I have been led to modify the opinion I had expressed of the affinities of our recent species, and to return to the view originally proposed by Desor and Lütken of uniting the recent West Indian species to the genus Rhynchopygus, regarding this, however, only as a subdivision of Cassidulus; for, notwithstanding the transverse position of the anus, covered in part by a projection of the test, and the absence of a prominent anal furrow, we find in the species of the genus Cassidulus indications that these characters are not of primary importance, though in the present state of our knowledge they may serve to subdivide the genus conveniently. The separation I had made in the Preliminary Report as Rhyncholampas of our recent Atlantic and Pacific species is not warranted; a series of C. Marmimi shows that the smooth band of the actinal surface and the position of the large tubercles are subject to great variation, reducing the distinctions to merely specific characters. The genus Rhynchopygus includes, as here limited, species with a thin test, well developed petaloid ambulacra; four genital openings; a transverse anal system placed above the edge of the test, covered by a projection of the overhanging interambulacral part of the test; a slightly marked anal furrow. The lower surface is slightly concave, sloping towards the outer edge; mouth eccentric anteriorly, bourrelets and phyllodes highly developed; a broad bare band extending from one extremity of the test to the other. Tubercles of the upper part of the test uniform, small, resembling Clypeastroid tubercles; tubercles of the lower part large, deeply sunken as in Spatangoids; adjoining bare band, they gradually diminish in size towards the edge of the test. Apical system more central than mouth, eccentric anteriorly.

Rhynchopygus caribaearum

! **Cassidulus caribaearum** LAMK 1801. An. s. Vert.
! *Rhynchopygus caribaearum* LÜTK. 1864. Bid. til Kunds.

Pl. XV. f. 1–4.

Mr. Pourtalès brought home fragments of this species showing that it must equal in size its Pacific representative. As it has been figured frequently, and described so well by Lütken, I will only call attention to a few points of difference between the East and West Coast species. The bare actinal band of the West India species is deeply pitted with longitudinal, round and elliptical pits and furrows (*Pl. XV. f. 3*), the edges surmounted by minute tubercles, carrying extremely delicate spines, resembling in every respect the structure of the microscopic spines of the fascioles of the true Spatangoids. This band is broad and elliptical, in the West India species, in the posterior actinal part of the test, while in the Pacific species it is narrow even near the actinostome, tapering very rapidly to a point near the anal extremity. The plates of the anal system, arranged in three rows, are broader and longer than in the Pacific species, where they are arranged in two rows only, the outer row being the largest. In the Pacific species the pits of the smooth band are reduced to a few indistinct impressions, the whole band being thickly covered by minute silk-like spines. The floscelle is most distinct also, while, owing to the sculpture of the bare band round the mouth in the West India species, its outline cannot always be distinctly traced.

There are unfortunately no specimens of these two species of the same size in any of the collections I have examined, making a more accurate comparison impossible; the Pacific species, being evidently full grown, will be described at greater length. The difference in the length of the poriferous zones both of the anterior and the posterior lateral ambulacra, so marked in the Pacific species, exist already in the smallest specimen, about three quarters of an inch in length, which I have examined. No pedicellariæ have been detected in this species.

Fragments in 106 fathoms.

SPATANGIDAE.

Family **Spatangidae** AGASS. 1841. Prod. Mon. Rad. (emend.)

ANANCHYTIDAE.

Subfamily **Ananchytidae** ALB. GRAS. 1848. Éch. foss. Isèr.

This subfamily includes Spatangoids having ambulacra flush with the surface of the test, the apical system more or less elongate, but not disconnected. The anterior groove disappears in some genera, as in Cassiduloids. The discovery of the genera Neolampas and Homolampas, where we find the spatangoid structure of the actinostome, as well as that of the form without bourrelets but with phyllodes, shows that the Ananchytidae are not as disconnected a group among Spatangoids as we have been led to suppose thus far, the genus Neolampas showing the possibility of finding Cassiduloids without the bare bands of the actinal surface, yet having the simple pores of the Ananchytidae and the peculiar structure of the mouth of the Cassidulidae, though not showing the faintest tendency to the development of plastrons so characteristic of the other Spatangoids.

POURTALESIA.

Pourtalesia A. AGASS. 1869. Bull. M. C Z., I. p. 272.

This genus is the living representative of Infulaster of the cretaceous period, holding the same relation to it which Rhynchopygus, with its projection covering the anus, holds to Echinolampas, if the posterior part of the test of the former were drawn out into a long spout. The outline of this genus, as well as of Infulaster, is very peculiar, and at first sight no one would take for a Sea-urchin the elongate, bottle-shaped body with its thin and transparent test. It is more like a Holothurian; the anus is at one extremity supramarginal, while the mouth is placed at the other. The short, vertical diameter, as compared to its length; the absence of any feature which would indicate the presence of a petaloid ambulacral rosette; the long, slender, curved spines, far apart, supported upon peculiar tubercles, mark this genus as one of the most interesting brought to light by

Mr. Pourtalès. It forms a valuable link in our appreciation of the affinities of Spatangoids proper with Spatangoids in which the mouth is not labiate.

Test thin, bottle-shaped, when seen from above; vertically truncated anteriorly, the anterior apex corresponding to the abactinal pole, in profile the outline is rectangular, convex below; the posterior actinal part of the test projecting far beyond the anus like a proboscis; the posterior extremity cut out to receive the pit occupied by the anal system. Seen endways, the test is heart-shaped; mouth elliptical, not labiate, sunken in a deep actinal groove; abactinal and actinal plastrons narrow, elongated, formed of closely packed tubercles. Tubercles few in number, with large scrobicular circle carrying long curved spines slightly fan-shaped at the extremity. Smaller spines spatulate; four genital openings. Ambulacral pores extending as simple rows from the apex to the actinostome. Ambulacral suckers pointed.

Pourtalesia miranda

!**Pourtalesia miranda** A. Agass. 1869. Bull. M. C. Z., I. p. 272.

Pl. XVIII.

Seen from above (*Pl. XVIII. f. 3*), the outline is bottle-shaped, the neck being the posterior extremity. At the base of the neck the test carries a deep pit, surmounted at its exterior extremity by a rostrum projecting from the test, and under this, at the bottom of the pit, is placed the anus (*Pl. XVIII. f. 6, 7*). Seen in profile, the anterior extremity is almost vertically cut off (*Pl. XVIII. f. 1*), the test arching regularly from the apical system to the rostrum, where it is abruptly cut off, forming a regular curve to the posterior extremity, this extends beyond the anal system like a snout thickened at the end (*Pl. XVIII. f. 5*), surmounted at its extremity by an accumulation of minute tubercles, colored dark violet, which carry no spines. The lower surface is convex, regularly arched from the posterior to the anterior extremity (*Pl. XVIII. f. 1*). The posterior pair of ambulacra extend on both sides of an elongated plastron to the base of the snout-like prolongation, where they curve sharply upwards, and run close to the abactinal part of the test (*Pl. XVIII. f. 1*), to the abactinal system situated almost at the summit of the nearly vertical anterior extremity, along a marked wedge-shaped ridge, extending from the apical system into the rostrum protecting the anus. The anterior pair of ambulacra take a similar course in the opposite direction, but curve more regularly (*Pl. XVIII. f. 4*),

following very nearly the edge of the deep anterior groove in which the odd anterior ambulacrum (*Pl. XVIII. f. 4*) is placed.

The odd ambulacrum is made up of two lines of pores far apart (*Pl. XVIII. f. 8*). The abactinal system, consisting of four large genital openings (*Pl. XVIII. f. 9*) placed close together, with the madreporic body tolerably well defined in the centre, is situated at the origin of the anterior groove; this is flanked by prominent ridges extending from the apical system, gradually disappearing towards the mouth, placed at the outer extremity of the anterior groove (*Pl. XVIII. f. 4*); this increases in depth on the lower surface (*Pl. XVIII. f. 2*), resembling in fact the anal groove of Echinobrissus, and allied genera, in an inverted position. The actinal system is elliptical, the long axis in the trend of the groove very large, with sharply defined edges covered by very minute plates (*Pl. XVIII. f. 8*). There are no indications of a floscelle. The odd ambulacrum carries large, thick tentacles, with rounded extremity, moderately close together (*Pl. XVIII. f. 19*); while the tentacles of the other ambulacra are placed, one for each plate, far apart, so as to readily escape notice, isolated as they are in the midst of the prominent and peculiar pedicellariæ which are so abundant, especially along the line of the posterior ambulacra. These pedicellariæ consist of a stem upon which articulate three slender, contractile arms (*Pl. XVIII. f. 16, 17, 18*), each terminating in a disk, with milled edges.* There is no petaloid portion in the ambulacra; they are all composed of simple pores from the mouth to the apical system. The spines are long, curved at the base, as in Spatangoids (*Pl. XVIII. f. 10*); the tubercles to which they are attached have a smooth scrobicular area. The mammary boss is small, crenulated, perforate in old, imperforate in younger tubercles, surrounded by a large granulated scrobicular area (*Pl. XVIII. f. 11*), and raised above the surface of the test, to which the milled ring is attached by a very flexible muscular membrane (*Pl. XVIII. f. 12, 13*). There are smaller spines of a similar structure, somewhat more fan-shaped (*Pl. XVIII. f. 14*); scattered irregularly over the test, but quite distant. The whole appearance of the test is bare, the primary tubercles carrying long spines being placed far apart in the lateral posterior interambulacral areas (*Pl. XVIII. f. 1*); and it is only on the ridges along the anterior groove, round the mouth and anus, that the small spatulate spines (*Pl. XVIII. f. 14*) are closely packed together.

* By an oversight, the description of these pedicellariæ, in the Preliminary Report, became connected with that of the tentacles.

Radiating from the apex towards the mouth, and extending along the abactinal plastron (*Pl. XVIII. f. 3*), there are masses of pigment cells forming lines of dark violet spots, also a similar series of spots round the extremity of the anal prolongation of the test, particularly marked on the edge of the pit leading to the anal opening. The test is extremely thin, transparent, of a bluish-gray color in alcohol, in this specimen, as well as in a still younger specimen collected by the Porcupine Expedition. In an older specimen, also dredged by the Porcupine Expedition, the test was much stouter. From the above description it is evident that Infulaster and the Ananchytidae must have had a structure allied to that of Pourtalesia, and are embryonic Spatangoids, still retaining some features of Clypeastroids, while the features characteristic of young Spatangoids are prominently developed.

A single specimen of this interesting genus was dredged at a depth of 349 fathoms.

HOMOLAMPAS.

Homolampas A. Agass. 1872. Rev. Echin. Pt. I.

This genus is intermediate between Cardiaster and Holaster. It has, like those genera, ambulacra flush with the test, but, unlike Holaster, has a well-developed anal and subanal fasciole, while it wants the lateral fasciole of Cardiaster. The ambulacral pores form no petals; they extend as simple pores between the ambulacral plates from the phyllodes to the apex. The actinal surface is flat; the actinostome is pentagonal, not bilabial, with well-developed phyllodes, but without trace of bourrelets,—a strong connecting link between the Cassidulidae and Spatangoids proper. The compactness of the apical system of this genus is in marked contrast with its structure in allied genera, such as Cardiaster and Holaster.

The general outline of the test resembles Maretia, but is somewhat more elongate. It is closely allied to Platybrissus, but the presence of a subanal fasciole, as well as a slight anterior groove, readily distinguish the two genera, in addition to the presence of a rudimentary rosette in Platybrissus, wanting in this genus.

Homolampas fragilis

! *Lissonotus* **fragilis** A. AGASS. 1869. Bull. M. C. Z., No. 9, I. p. 273.
! **Homolampas** *fragilis* A. AGASS., 1872. Rev. Ech. Pt. I.

Pl. XVII. f. 13–21.

Test thin; from above heart-shaped, elongate (*Pl. XVII. f. 15*). Seen in profile (*Pl. XVII. f. 14*), it is regularly arched anteriorly from the lower side to the apex, running then almost horizontally, and abruptly bevelled at the posterior extremity. The ventral plastron is small (*Pl. XVII. f. 13*), triangular, surmounted by an elliptical subanal fasciole (*Pl. XVII. f. 19*), surrounding the anal plastron, which projects like a rounded keel below the anal system. The spines of the lower surface are large and few in number, confined entirely to the edge of the test, leaving broad, bare bands in the ambulacral areas and adjoining parts, while on the rest of the test the tubercles are minute, carrying small, fine spines, with the exception of three large, crenulate tubercles (*Pl. XVI. f. 21*), surmounted by curved spines (Lovenia-like) placed near the edge, in the anterior extremity of the test (*Pl. XVII. f. 17*). The tubercles are also somewhat larger on the sides of the anterior groove, and more closely packed in the posterior interambulacral space, from the apex to the anal system, than in remaining parts of the test. The plates of the two posterior ambulacra are comparatively broad, while all the other ambulacra are made up of smaller plates. The actinal system is pentagonal, the mouth is placed near the posterior edge (*Pl. XVII. f. 16*). The tentacles of the phyllodes are represented in different stages of development in *Pl. XVII. f. 20.* The portion of the poriferous zone extending from the phyllodes to the apical system is made up of simple pores, one for each ambulacral plate, so that the ambulacral areas, seen from above, are scarcely perceptible, marked only by the somewhat more closely packed minute tubercles (*Pl. XVII. f. 18*) covering the ambulacral plates. There are three large genital openings; the right anterior one is obliterated. The anal system is transversely elliptical (*Pl. XVII. f. 19*), its membrane is covered by minute granulation; an indistinct branch of the subanal fasciole extends along the lower side of the opening; the anus itself opens in a delicate tube, similar to that of Neolampas, but shorter, frequently forming a mere lip. The whole test is mottled with dark spots; the ground-color is grayish, with a purplish tinge.

From 320 to 368 fathoms.

SPATANGINA.

Subfamily **Spatangina** Gray, 1855. Cat. Rec. Ech.

ECHINOCARDIUM.

Echinocardium Gray, 1825. Ann. Phil.

Test thin, heart-shaped. Ambulacral petals more or less triangular, interrupted at apex by an internal fasciole ; pores of lateral pairs of ambulacra distant, broad anterior ambulacrum formed of small pores situated in a more or less distinct groove. Anal system placed in the vertically truncated posterior extremity. Subanal fasciole with ascending branches around anal system. Spines of lower surface long, spatuliform, while those of the rest of the test are thin and silk-like. I attempted formerly to distinguish Amphidetus and Echinocardium on account of the more ovoid shape of the test and the disconnected posterior fascioles of (Amphidetus) Echinocardium flavescens; the little thus far known of the development of Echinocardium cordatum shows satisfactorily that such characters are not generic.

Echinocardium cordatum

Echinus **cordatus** Penn. 1777. Brit. Zoöl.
! *Echinocardium cordatum* Gray, 1848. Brit. Rad.

Pl. XIX. f. 10–17 ; Pl. XX. f. 5–7.

Test thin, heart-shaped from above, vertex posterior, test rising gradually as a rounded keel beyond the internal fasciole, truncated at both extremities, odd ambulacrum sunken more than the lateral ones, the test forming a ridge on both sides of the anterior depression. The abactinal portion of the odd sunken ambulacrum is bounded by the broad internal fasciole, this gradually becomes narrower towards the anterior extremity. The pores of the odd ambulacrum are small, comma-shaped, so closely packed together on the flat portion of the groove as to alternate, though arranged singly towards the abactinal pole and towards the actinostome. Four ovarian openings diverging posteriorly. The anterior rows of pores of the lateral ambulacra are obliterated by the internal fasciole. The lateral ambulacral petals are triangular ; adjoining rows of pores of the lateral ambulacra form crescents in the lateral and posterior ambulacral spaces. The anal system is vertically elliptical. The

subanal fasciole is lanceolate, extending to a beak, bounded by a broad fasciole, narrowing rapidly towards the actinal surface. The bare ambulacral spaces round the mouth taper rapidly towards the edge of the test. The spines are short, hair-like, except on the oval plastron and the edge of the test, where they are large and spatulate. Color, when alive, yellowish-white. Alcoholic specimens often of a gray color, with pinkish tinge or darker yellowish.

The specimens of this species collected upon our shores had in the Preliminary Report been referred to *Echinocardium* **Kurtzii** of Girard, for want of sufficient European material to make a satisfactory comparison of the specimens occurring on both sides of the Atlantic. This comparison has now been made, and shows the identity of the specimens from both sides of the Atlantic. Fragments of this species were collected by Mr. Pourtalès. Our American specimens, of which the Museum possesses excellent series, show differences confined almost entirely to a portion of the test, subject to the greatest variation in Spatangoids. These consist in the greater prominence of the posterior abactinal interambulacral ridge, the more circular anal opening covered by a slightly larger number of plates than in the European specimens, where they are often larger and fewer in number; the extremity of the subanal plastron also projects, and is more prominent; — differences which can be found in a large series from any one locality in different individuals.

Littoral to 85 fathoms.

Young specimens measuring only 6.3$^{mm.}$ in longitudinal diameter have already a labiate mouth, and, as in young Brissopsis, we find very early all the generic features of Echinocardium fully developed, and no one could fail to recognize even in such small specimens the young of E. cordatum. The anterior ambulacrum is as deeply sunk, in proportion to the size of the specimen (*Pl. XIX. f. 11*), as in the adult specimens; the intrapetalous fasciole is fully laid out (*Pl. XIX. f. 15*), though it has a very different outline, being triangular; the lateral ambulacra are totally disconnected as yet; the petals are still linear (*Pl. XIX. f. 15*), and have not yet assumed the characteristic triangular shape of the adult (*Pl. XIX. f. 16*); the anal membrane protrudes, somewhat trumpet-shaped, from the anal system; the subanal fasciole and anal branch are at first united (*Pl. XIX. f. 14*), but as the specimens increase in size, the anal branch separates from it (*Pl. XIX. f. 17*). The actinal plastron is extremely prominent, and in young specimens the outline of the posterior extremity in profile resembles E. mediterraneum. The

odd ambulacral zones are at first two single rows of pores (*Pl. XIX. f. 15*), which by closer crowding eventually alternate, but are not arranged in pairs (*Pl. XIX. f. 16*).

Echinocardium flavescens

Spatagus flavescens MÜLL. 1776. Prod. Zool. Dan.
! *Echinocardium flavescens* A. AGASS. 1872. Rev. Ech., Pt. I.

Pl. XX. f. 3, 4.

Test oval; stouter than in the other species of the genus; seen in profile quite regularly arched, though truncated at the posterior extremity, the posterior interambulacral ridge extending over the anal system. The ambulacra are very slightly sunken, not as much as in E. cordatum, but more than in E. mediterraneum; the anterior one is frequently nearly flush with the test. The abactinal pole is nearly central. The internal fasciole is elliptical, remarkable for the great breadth of the space it encloses. The actinostome of this species and of E. pennatifidum is not narrow and transverse as in the species mentioned above; it is broader, with a straighter posterior lip. The anal system is large, slightly elliptical, transverse. The color, when alive, is pinkish.

An examination of young specimens of Echinocardium cordatum shows that the generic distinction which I attempted to make between Amphidetus and Echinocardium, based upon the isolation of the anal from the subanal fasciole, and thus separating the group with a deep anterior groove from these with a slight anterior groove, is untenable. The presence of two identical species of Echinocardium on both sides of the Atlantic is certainly remarkable, but I am unable to distinguish the fragments of specimens collected by Mr. Pourtalès and unmistakably identical with a fine specimen of Echinocardium flavescens collected at Charleston, S. C., in the Museum collection, from European specimens of this species.

— to 128 fathoms.

Echinocardium pennatifidum

Amphidotus gibbosus (**Barrett**), 1857. Ann. Mag. N. H., XIX. p. 32 (non AGASS.).
Echinocardium **pennatifidum** NORM. 1868. 4th Dredg. Rept.

Pl. XX. f. 1, 2.

This species combines the general appearance of Echinocardium mediterraneum with the structure of E. flavescens. Its outline resembles that of E. cordatum, but it has, like E. flavescens, the anterior ambulacrum scarcely sunken.

It has a high test, the ridge between the posterior ambulacra being quite prominent, regularly arched as in E. flavescens, but extending as a well-marked rostrum over the anal opening; this is somewhat pear-shaped, and comparatively smaller than in the other species of the genus; the arrangement of the anal plates is similar to that of E. flavescens; the apical part of the odd ambulacrum is narrow, the internal fasciole being very elongated, elliptical, including an extremely narrow space, the sides of the test sloping up very gradually like a roof towards the apex, which is anterior, and placed at a distance of about one fourth the longitudinal diameter of the test from the anterior extremity, thus differing strikingly from either E. flavescens or E. cordatum, in which the junction of the ambulacra is either almost central or eccentric posteriorly; the posterior ambulacra are much shorter than in E. flavescens. The whole upper surface of the test is covered with very minute tubercles, as in E. cordatum, with the exception of a few larger ones along the edge of the anterior ambulacral zone. On the lower side they are large, as in E. flavescens, having the same general outline; the bare actinal spaces are far wider, the tubercles not extending so far towards the mouth from the ambitus as in E. flavescens. The posterior extremity is almost vertically truncated, the plastron is much smaller than in E. flavescens; the subanal plastron is less broad, and higher.

Length.	Trans. Diam.	Height.
37.1	31.7	21.

From 79 – 121 fathoms.

The existence of a species of Echinocardium having the outline of Echinocardium cordatum, but the slight odd ambulacral groove of Echinocardium flavescens, is an additional proof of the identity of Echinocardium and Amphidetus, as they had been limited in the Museum Bulletin, No. 2. The present species, of which but a single specimen was collected, is closely allied to E. mediterraneum; not having in 1869, when the Preliminary Report was written, sufficient material to make a thorough comparison which might prove their identity, I gave the points of difference observed in the specimens compared. A good figure of *E.* **pennatifidum** of Norman having been given by Hodge in the Transactions of the Northumberland and Durham Natural History Society, there seems but little doubt that the species I called **laevigaster** in my Preliminary Report is the same as the E. pennatifidum dredged by him on the west coast of Scotland.

BRISSINA.

Subfamily **Brissina** GRAY, 1855. Cat. Rec. Ech.

AGASSIZIA.

Agassizia VAL. 1846. Voyage Vénus, Atlas.

Test thin, ovoid, differing from all other Spatangoids in having the anterior pair of petals composed of single poriferous zones. Peripetalous fasciole and lateral fasciole connected and passing under anus.

Agassizia excentrica

! *Agassizia* **excentrica** A. AGASS. 1869. Bull. M. C. Z., No. 9, I. p. 276.

Pl. XIV. f. 9–12; Pl. XI^f. f. 23, 24.

I am somewhat inclined to consider this species as the Agassizia porifera; but not having any original specimens for comparison, and the drawings of Ravenel and McCrady showing rather striking differences, I will not take their identity for granted, and compare it only with its West Coast representative, from which it can at once be recognized by the position of the apical system, which is much more eccentric posteriorly; on this account the disparity between the odd anterior pair of ambulacra and the posterior pair is greater than in that species. The interambulacral plastron is elliptical, and with this exception the arrangement and proportion of the tubercles is that of **A. scrobiculata** VAL. The peripetalous fasciole does not pass below the ambitus, and the posterior fasciole makes a sharp angle under the anal opening. Only two denuded tests were collected, so that no further details can be given about this species.

From 36 to 115 fathoms.

It is with considerable doubt that I refer to Agassizia small Spatangoids (*Pl. XIV. f. 9–12*) having, like it, a peripetalous and lateral fasciole and the peculiar structure of the ambulacral petals of the genus, not limited, however, to the anterior ambulacra, but extending to all the petals. The flat test (*Pl. XIV. f. 12*) is also unlike what has thus far been found to be the shape of young in other Spatangoids (Moira, Echinocardium, Spatangus), and further material may yet prove this to be the young of an undescribed Spatangoid,

though, judging from the analogy, there is nothing excepting the flatness of the test which would be contrary to its being the young of either Agassizia or Schizaster.

The young Agassizia, 6.2$^{mm.}$ in length, is a flat elliptical Spatangoid (*Pl. XIV. f. 9*) resembling Gualteria. The peripetalous and lateral fascioles have the same general limits as in the adult, but the arrangement of the pores in all the ambulacra is identical (*Pl. XIV. f. 11*); there is but a single pore for each ambulacral plate, as it exists in the anterior pair and odd ambulacra of the adult; the ambulacral grooves are not yet formed, the anterior groove alone being slightly indicated; the mouth is very slightly labiate (*Pl. XIV. f. 10, 12*).

(HEMIASTER.) Brissopsis.

Brissopsis Agass. 1840. Cat. Syst. Ectyp.

Test thin, more or less ovoid; the apex is nearly central, the odd anterior ambulacrum but little prominent, ambulacral petals unequally developed. Subanal fasciole and peripetalous fasciole entire. This genus does not seem to be entitled to rank as more than a subgenus of Hemiaster, where we have a subanal fasciole; while Toxobrissus, which is said to have no subanal fasciole, cannot, it seems to me, be separated from Hemiaster simply on account of the divergence of the ambulacra as proposed by Desor, a feature which is strictly one of growth, and not one to be taken as a permanent character. Kleinia, as based upon the original specimen (**Kleinia luzonica**) of Gray, certainly is nothing but a Brissopsis, having a most distinct subanal fasciole. If the subanal fasciole is really absent in Toxobrissus, it cannot, as Lütken considers it, be identical with Kleinia. It may be that other characters will yet be traced to separate it from Brissopsis; if not, then Kleinia and Toxobrissus will both become synonymous with Brissopsis.

Brissopsis lyrifera

! *Brissus* **lyrifer** Forbes, 1841. Brit. Starf.
! *Brissopsis lyrifera* Agass. 1847. C. R. Ann. Sc. Nat.

Pl. XIX. f. 1–9; Pl. XXI. f. 1–2.

Test thin, ovoid, depressed; profile regularly arched, truncated posteriorly; vertex posterior; peripetalous fasciole moderately broad, somewhat flexuous; posterior portion very distinct, less clearly defined towards anterior; all am-

bulacral petals uniformly sunken, posterior ambulacra shortest. Tubercles more closely crowded within the peripetalous fasciole; four ovarian openings close together, nearly central. The pores of the lateral ambulacra are so arranged as to form equally distant longitudinal rows. The anal system is nearly circular, slightly elliptical vertically, distant from the subanal fasciole, with a row of large plates round the exterior edge, the largest plates near the anal fasciole, the remaining part covered by small plates. The subanal fasciole is elliptical, strongly concave towards the anal system, sending off an indistinct branch to the peripetalous fasciole. The tubercles of the subanal plastron are closely packed, the spines usually arranged in two tufts on each side of the median line. There are but few tubercles in the prolongation of the petals; they are also less numerous in the median interambulacral spaces, where the test is frequently quite bare. The actinal plastron is very prominent, and the whole actinal surface is crowded by large tubercles of uniform size, largest near the actinostome. The bare ambulacral spaces are very broad, particularly the posterior ones. Forbes says of its color when alive, "a red body with pale yellowish spines, the dorsal and postanal impressions of a rich brownish-purple."

The only difference to be traced, after a careful comparison, between Florida and European specimens, is the existence of a distinct branch of the subanal fasciole extending round the anal system to the peripetalous fasciole (*Pl. XIX. f. 4*). In European specimens there are traces of this branch, but it is not distinctly and sharply defined as in the Florida specimens. The subanal fasciole seems, from all I can gather after an examination of Spatangoids in various stages of growth, the only one subject to decided changes, and it is not remarkable that we should have in Brissopsis similar variations, in the subanal fasciole, to those upon which Troschel has founded his genera Abatus, Hamaxitus, and Atrapus, — changes which, in Brissopsis at least, are due to different stages of growth. The character of continuity of the adjoining pairs of ambulacra, which Desor assigns to Toxobrissus as a distinguishing feature, becomes more and more apparent according to the size of the specimens; so much so, that we should place Brissopsis lyrifera, when young, in Brissopsis, but when full grown it would most decidedly pass for a Toxobrissus.

Young Brissopsis lyrifera, less than a quarter of an inch in length, are cylindrical (*Pl. XIX. f. 1–3*), the mouth having a flat, crescent-shaped edge (*Pl. XIX. f. 3*), the test truncated vertically at the posterior edge (*Pl. XIX. f. 2*), surrounded by a prominent elliptical subanal fasciole; the peripetalous

fasciole is elliptical, undulating; the anus is placed near the posterior extremity of the peripetalous fasciole. In still younger specimens the peripetalous fasciole is rectangular, with rounded corners and concave sides, extremely broad (*Pl. XIX. f. 7*), while, as it widens with the increased length of the ambulacra, it becomes much narrower.

The odd ambulacrum carries four or five large tentacles with lobed disk (*Pl. XIX. f. 2*); the pores of the odd ambulacrum are single, not in pairs; the other ambulacra are short, straight, well defined, consisting of three and four pairs of pores not yet conjugated (*Pl. XIX. f. 7*). In older specimens the posterior edge of the mouth becomes labiate, the anus approaches the subanal fasciole, which sends out a rudimentary anal branch (*Pl. XIX. f. 4*), eventually uniting with the peripetalous fasciole, the outline of which becomes more pentagonal (*Pl. XIX. f. 8*), undulating, and elongated with the increasing size of the petaloid ambulacra. The posterior edge becomes more bevelled with age (*Pl. XIX. f. 6*), the subanal plastron more prominent, the lateral pairs of ambulacra gradually tend to unite, passing from a strictly Brissopsis outline (*Pl. XIX. f. 8*) to one considered hitherto characteristic of Toxobrissus (*Pl. XIX. f. 9*). The spines in all young Spatangoids are strikingly larger in proportion to their size than in the adult.

From 55 to 156 fathoms.

BRISSUS.

Brissus Klein, 1734. Nat. Disp.

Echini with elongate test; apex eccentric anteriorly, often attaining very large size; anterior ambulacrum nearly obliterated, flush with test, or placed in a furrow of little depth. Other petals more sunken; anterior ambulacra more transverse than the posterior. Anal system moderately large; tubercles, except on each side of anterior furrow, and within the peripetalous fasciole, remarkably uniform in size; peripetalous fasciole exceedingly angular, with a very prominent subanal fasciole; four genital pores, anterior small, close together, posterior ones larger and distant; spines very uniform in size, except on the actinal surface and on each side of the bare band, where they are quite long and well developed.

Brissus unicolor

! **Brissus unicolor** KLEIN, 1734. Nat. Disp. Ech.

Pl. XXII. f. 1, 2.

A large number of species of the genus Brissus have been named, but when we attempt to define their specific differences we have but a small number left which can be distinguished with any degree of certainty. A fine series of specimens from the Mediterranean which the Museum owes to the kindness of Professor Panceri and Mr. Rigacci, specimens from the Cape Verde and Canary Islands, the collections of Paris and of Professor Haeckel, show such an extraordinary variation in all the characters which have been employed to distinguish the species of this genus, that I have not found anything left to separate them beyond the usually somewhat more elongate shape of specimens coming from the Mediterranean, while those from the Cape Verde and Canary Islands agreed completely with the West India specimens. The only features by which I am able to separate the two undoubted species of Brissus (B. carinatus and B. unicolor) are the proportions of the anterior and posterior pairs of ambulacra, and the striking difference in the course of the fasciole in the anterior part of the test. In Brissus carinatus the posterior ambulacra are much shorter than the anterior pair, while they are nearly equal in B. unicolor. There is but one re-entering angle in anterior part of fasciole in the anterior interambulacra, while there are two in B. carinatus; some minor points of difference in these species will be pointed out hereafter in the descriptions. The outline of the West India specimens is usually elliptical, slightly broader posteriorly; anal extremity vertically truncated, and apex posterior; test sloping very slightly from abactinal system to apex, forming a broad rounded keel, not specially prominent in the posterior interambulacral space. Posterior extremity of the test uniformly tuberculated, while the larger tubercles of the edge of the lower surface extend over the anterior extremity, slightly beyond the anterior pair of ambulacra, and within the peripetalous fasciole, which is narrow, deeply re-entering in the median lower posterior and odd interambulacral spaces.

Lower surface slightly convex; actinal plastron elliptical, terminated by a narrow fasciole, forming a well-defined subanal area, elliptical, deeply indented below the anal system, broader than the actinal plastron. Anal system large, elliptical, composed of one exterior row of large polygonal plates; interior ones smaller and irregularly arranged.

Spines of dried specimens of a yellowish-brown color, comparatively long, especially in the anterior part of the test. Mouth large, longitudinal and transverse diameter nearly as one to two; posterior lip but little prominent.

Genital openings round, close together; posterior ones largest, slightly more distant; madreporic body prominent.

The anterior odd ambulacrum is flush with the test, and is marked by a distinct narrow band of closely crowded small tubercles extending from the abactinal system to the margin of the test between the two rows of large pores forming the odd ambulacrum.

In smaller younger specimens we find the broad rounded posterior keel less well defined, the anal system comparatively much larger, the subanal plastron more elliptical, and the tubercles of the anterior extremity proportionally much less prominent. Mouth comparatively more circular, ratio of transverse to longitudinal diameter being two to one and a half.

Littoral.

Long Diameter	Transverse Diameter.	Height	Ant. Pair Amb.	Post. Pair Amb	Breadth of Actinal Plastron.	Breadth of Subanal Area.
83	69	46.	28.	37.	37.5	35.4
64	51	38.5	21.5	26.5	28.	24.
52	39	27.	14.5	17.6	19.1	16.3
39	29	21.5	12.	14.5	14.1	15.9
28	21	14.	7.2	9.2	10.	13.

(BRISSUS.) Meoma.

Meoma Gray, 1851. Ann. Mag. N. H.

Shell moderately stout, heart-shaped; ambulacra (except odd one) sunk in deep groove, the anterior and posterior pair nearly equal; anterior ambulacrum indistinct. Peripetalous fasciole sinuous; subanal fasciole more or less imperfect, usually extending to the level of anal system as an open curve.

Meoma ventricosa

! *Spatangus* **ventricosus** Lamk. 1816. An. s. Vert.
! *Meoma ventricosa* Lütk. 1864. Bid. til Kunds. om Echin.

Pl. XX. f. 8; Pl. XXII. f. 3, 4.

Test moderately stout, broadly elliptical, slightly heart-shaped from above. Actinal surface, with the exception of the projecting posterior lip of the actinostome, flat; anal extremity obliquely truncated towards sloping actinal surface; regularly arched from the edge of the test to the apex; apex anterior, corresponding nearly with the abactinal centre; regularly arched from anal and

anterior extremity to apex, lateral ambulacra deeply sunken, posterior pair somewhat longer than anterior pair, which diverges at a much greater angle from the scarcely marked odd anterior ambulacrum ; this is placed in a very slightly marked anterior groove. Peripetalous fasciole of uniform breadth, well defined, four genital openings diverging posteriorly. On the interambulacral plates, enclosed by the fasciole, the tubercles are arranged in single rows parallel to the suture; the rest of the test is covered by closely packed, uniform-sized tubercles, carrying short, sharp spines. The tubercles of the actinal part of the test are larger immediately adjoining the ambulacra, diminishing in size towards the edge and towards the central part of the actinal plastron. This plastron is bottle-shaped, short-necked, near the actinostome, with a very indistinct keel near the central portion, bounded posteriorly by the narrow, usually open, subanal fasciole, the anal extremity of which is bent near the base of the anal system. The actinostome is deeply sunken, the posterior lip extremely prominent and projecting almost as far as the anterior edge of the actinostome. The anal system is small, elliptical, covered by irregular polygonal plates carrying spines, diminishing rapidly in size towards the anal opening. The edge of the interambulacra adjoining the ambulacral plates of the lower side, the space round the anal system and round the actinostome, is closely crowded with two kinds of pedicellariæ, one with short head, broad base, and short arms, the other with long triangular arms. Both are carried upon moderately long, stout stems.

A small specimen of Meoma, not measuring quite an inch in length, which D'Orbigny had described as Schizaster cubensis, showed no special points of difference from the adult.

Lütken first referred this species to the genus Meoma of Gray, established for a presumed Australian species, M. grandis. Lütken also, in 1863, called my attention to the generic identity of *Kleinia* **nigra**, A. Ag., with Meoma, which I had with doubt referred to Kleinia. This mistake I was led into by the fact that Gray himself did not refer Brissus ventricosus to Meoma, but still retained it in a section of Brissus. This shows how little value the subdivisions which Gray so frequently introduces in his genera of Echini must have (often copied without any attempt at a more accurate discrimination of the species from similar headings in the Catalogue Raisonné), when two species as closely allied as Meoma ventricosa and Meoma grandis are placed in two genera ; or when in the subdivisions of Echinocardium, as another instance, Echinocardium ovatum is placed in the subdivision of the genus

with "*deep, odd ambulacral groove*," instead of being placed in the same subdivision as E. mediterraneum. The genus Kleinia I am unable from Gray's specimens to distinguish from Brissopsis. **Meoma grandis** GRAY, from a careful comparison of the originals of Gray, I consider as identical with Meoma nigra (*Kleinia* **nigra** A. AG.). The locality quoted by Gray is undoubtedly erroneous, Captain Belcher, as Lütken mentions in his "Bidrag," having visited Central America; and the fact that we have in the British Museum, brought back by Belcher, an *Agassizia* **subrotunda** GRAY, **Meoma grandis** GRAY, and an *Echinanthus* **testudinarius** GRAY, marked "Australia," neither of which can be distinguished from Agassizia ovulum, Meoma nigra, and Clypeaster speciosus, found upon the west coast of Central America, seems to indicate without much doubt an error in the localities of the specimens of Gray's Catalogue.

Littoral to 85 fathoms.

(BRISSUS.) METALIA.

Metalia GRAY. 1855. Cat. Rec. Ech. (emend.)

The subgenera Plagionotus and Metalia are united as a single subgenus of Brissus (Metalia). The slight differences in the course of the peripetalous fasciole and the presence of larger tubercles not being sufficient ground, with our present knowledge of the changes due to growth, to warrant retaining them both, and as Plagionotus is already in use among Coleoptera, the subgenus proposed by Gray has been adopted and emended to include Brissidae having a more or less broad, elliptical, or undulating re-entering peripetalous fasciole, and an anterior ambulacral groove. Lateral ambulacral petals narrow, elongate; pores well separated; apex anterior; actinal plastron narrow, heart-shaped; subanal area bordered by a broad fasciole, with anal branches connected with it; subanal ambulacral pores sending radiating grooves towards the centre of the subanal area. Actinostome anterior, crescent-shaped. Tuberculation in the peripetalous fasciole coarse, frequently consisting of primary tubercles. Spines short, slender, curved; those of actinal surface longer, curved, broad at base of milled ring. Haime suggested the propriety of uniting Eupatagus with Plagionotus, but as Desor justly notices, the difference in structure of the ambulacra shows that they have only superficial characters in common, Eupatagus being closely allied to Spatangus, and not to Brissus, as is the case with Plagionotus.

Metalia pectoralis

Echinus **grandis** GMEL. 1788. LINN. Syst. Nat.
! *Metalia pectoralis* A. AGASS. 1872. Rev. Ech., Pt. I.

Pl. XXI. f. 4, 5.

The specimens of this species usually preserved in museums are almost invariably denuded tests, and we have therefore a very imperfect idea of the natural features of this fine Spatangoid. The few spines still remaining on one of the specimens I have seen, corresponding to the small tubercles covering the test, are quite short, greatly curved; those of the large tubercles within the peripetalous fasciole I have not seen. On a small specimen, part of the spines of the actinal side are still left; they resemble the spines of Lovenia, are long, slender, strongly curved eccentrically near the broad base, so that we may assume that the spines of the large dorsal tubercles were probably of the same structure. The test is thin, more or less elliptical, though with increasing size the edge becomes somewhat angular, the median interambulacral spaces re-entering slightly. The outline in profile is regularly arched in small specimens, but in older ones we frequently find a gradual sloping of the test from the edge to the apex, others retaining the more regularly arched outline. The vertex is anterior, corresponding to the abactinal system. The odd anterior ambulacrum is placed in a slight groove. The anterior pair of ambulacra are shorter than the posterior, — the anterior slightly curving anteriorly, the posterior diverging, on the contrary, at the extremity. The peripetalous fasciole is broad, sometimes sunken, somewhat elliptical, except the anterior angle made previous to crossing the odd ambulacrum. A slight ridge extending to the apex divides the anterior interambulacrum into a portion bearing large tubercles next to the anterior pair of ambulacra, and into the part adjacent to the odd ambulacrum, where the primary tubercles are numerous but small. The whole space of the lateral interambulacrum above the peripetalous fasciole is crowded with large primary tubercles with a broad scrobicular circle, except the part immediately adjoining the posterior edge of the anterior ambulacra, which is divided by a slight ridge from the remaining part of the interambulacral space. The same is the case with the narrow posterior interambulacral space; a ridge separates the space free of tubercles adjoining the posterior edge of the posterior ambulacrum from that covered by tubercles; the tubercles of the odd posterior interambulacrum are smaller than those of the lateral posterior ambulacra, where the primary tubercles take the greatest development. The difference between the length of

the lateral ambulacra is less marked in young specimens. The anal system is placed in a depression in the obliquely truncated posterior extremity of the test; it is pear-shaped, the small end turned towards the abactinal pole, often rising above the edge of the test. The plates covering the anal system are irregular, nearly of uniform size; the plates covering the membrane immediately surrounding the anal opening are minute, occupying the greater part of the actinal portion of the anal system; in the smallest specimen measured the posterior extremity is truncated vertically, there being but a slightly marked anal depression, which becomes afterwards so prominent with advancing age as to form in large specimens cheeks on each side of this depression at the angle of the subanal fasciole and the anal branch. The whole upper surface of the test is covered by minute tubercles, forming a regular granulation below the peripetalous fasciole to the edge of the test. Above the fasciole the tubercles are slightly larger and more distant, especially when forming the scrobicular circle round the primary tubercles. The genital openings are circular, diverging posteriorly, with prominent comma-shaped madreporic body extending into the posterior interambulacrum.

The actinal plastron is elongate, narrow, with a marked keel at the posterior extremity extending to the base of the broad, heart-shaped subanal plastron, has four pores, completely surrounded by a broad fasciole, lobed internally. The anal fasciole is independent of the subanal, being separated from it by an extremely narrow ridge of minute tubercles; the horizontal part is broad; the upper branches narrow, and extend to the edge of the test. The tubercles of the actinal surface are largest outside of the ambulacral rows, gradually decreasing towards the edge of the test; the tubercles of the actinal plastron are considerably smaller, and more closely packed. In large specimens the suture of the plates on the upper part of the test are slightly sunken, the plates themselves sloping from a vertex or ridge towards the edges, — a feature not prominent in younger specimens, thus forming ridges dividing the interambulacrum into distinct fields. The fine figure of this species given by Seba is one of the best which can be given, and will serve, as many of his figures do now, to readily identify many species of Echini. The mouth is comparatively narrow transversely, distinctly rounded anteriorly, with a straight, raised posterior edge. The actinal membrane is covered by polygonal plates, closely crowded, except the anterior row of plates, which is the largest, decreasing gradually to the posterior edge.

The identity of the pliocene and post-pliocene species cited in the synonymy

of this as well as of others of our Eastern Coast species, is of course problematical; yet the differences indicated by McCrady do not indicate as great a range of variation as we find in living species. I have quoted the figures for the sake of calling attention to them. There are, in addition, other tertiary species described by Michelin and by Guppy, coming from the Gulf of Mexico and the West India Islands; but as their material was inaccessible to me, I have not attempted to point out their affinities.

Littoral and fragments from 115 fathoms.

Width of Mouth.	Longitudinal Diameter.	Transverse Diameter.	Height.	Anterior Pair Amb.	Posterior Pair Amb.	Distance of Mouth from Ant. Extremity.	Distance of Vertex to Anterior Extremity.	Breadth Actinal Plastron.
19.5	157.	123.8	58	51.	62.5	33.	57.	29.
16.5	130.5	96.	40	39.2	53.	25.8	49.8	19.2
18.7	116.	91.	44	39.	52.2	24.	41.	21.8
9.5	62.	46.	27	16.2	21.8	14.	20.5	13.5

SCHIZASTER.

Schizaster AGASS. 1836. Prod.

Test thin, elongate; apex posterior; great difference between length of anterior and posterior pairs of ambulacra. The anterior ambulacrum placed in a deep, broad groove; anterior and posterior petals somewhat sunken and diverging; the anterior are nearly parallel with anterior groove. Genital pores varying in number from two to three. Peripetalous fasciole angular, running close to the ambulacral petals, with a narrow lateral fasciole starting from the anterior ambulacra and passing under the anal system, with elongate, triangular swellings. Posterior lip of bilabiate actinostome very prominent, turned back, rising to a rounded beak in front of actinal plastron.

Schizaster fragilis

! *Brissus* **fragilis** DÜB. & KOR. 1844. Skand. Echin.
! *Schizaster fragilis* AGASS. 1847. C. R. Ann. Sc. Nat.

Pl. XXI. f. 3.

Test depressed, vertex and apical system almost coinciding; three genital openings, right anterior obliterated. Compared with S. canaliferus, the odd ambulacral groove is less broken and narrower; the pores arranged in a most regular line; the pores of each pair separated by prominent, elongate tubercles, making a beautiful line of beads from the apex to the peripetalous fasciole, the flat space intervening between the poriferous zones being covered by small tubercles and granules of little prominence, except the outer rows near the poriferous zone; the lateral ambulacra are but slightly sunken,

the anterior and posterior both diverging more than is the case in S. canaliferus, and the posterior ambulacra are proportionally longer. The posterior genital openings are distant, the madreporic body well developed between them, extending posteriorly. The peripetalous fasciole widens into a broad, triangular space at the extremity of the anterior ambulacra, extends straight across from tip to tip, the two posterior ambulacra making quite a re-entering angle between the anterior and posterior lateral ambulacra. Lateral fasciole running parallel to the ambitus. Outline of the test from above is somewhat diamond-shaped, with rounded angles. Seen in profile, the test tapers very gradually towards the actinostome posteriorly, regularly arched to the anal system; posterior extremity abruptly truncated, receding below the anal system; the subanal fasciole runs in a curve under the anus in a depression between the projecting cheeks of the adjoining ambulacral plates, — a condition of things in striking contrast with the prominent keel formed at the extremity of the actinal plastron by the angular exterior of the subanal fasciole in S. canaliferus. Actinal side flat, with broad bare ambulacral zones; actinal plastron elliptical, posterior extremity not well defined, losing itself in the tubercles of the test under the subanal fasciole.

Anal system covered by a large number of small plates carrying each a small spine.

The spines of the upper part of test are short, spathiform; tuberculation larger towards the anterior extremity and near the ambulacra, size of spines corresponding to this. The tubercles of the lower side are far apart near the edge of the test and of the ambulacral zones; those of the actinal plastron are closely crowded, while adjoining the anterior groove they become very prominent.

The fragments of Schizaster found by Mr. Pourtalès were referred to in the Preliminary Report as Schizaster cubensis. Having since that time received specimens of Schizaster fragilis from Dr. G. O. Sars and Professor Thomson, there can be no doubt that the fragments belong to this species, as they are the greater portion of the anterior part of the test. An examination of the original specimens of D'Orbigny's S. cubensis shows them to be young Meoma ventricosa.

Mr. Whiteaves has dredged specimens of this species in 250 fathoms in the Gulf of St. Lawrence.

80 fathoms, fragments.

Longitudinal Diameter.	Transverse Diameter.	Height.	Distance of Vertex to Posterior Extrem.	Posterior Ambulacra.	Anter. Pair Ambulacra.	Actinal Plastron.
55	58	32	24.5	9.5	25.1	20
51	51	29	21.5	8.	23.	19

MOIRA.

Moira A. Agass. 1872. Rev. Ech. Pt. I.

Test moderately thin, ovoid; ambulacral petals sunken; test bulging towards interior in five pouches from five narrow deep grooves, like radiating spokes from the abactinal pole, edged by the peripetalous fasciole which forms round them a smooth border. Lateral fasciole passing at a considerable distance under the anal system, as in Agassizia and Schizaster; tubercles arranged upon the upper surface diagonally. Actinal plastron elongated, pentagonal, covered by larger tubercles, with ill-defined scrobicular circle carrying spathiform spines; only two posterior genital openings. Anterior groove extending to actinostome.

Gray has subdivided Schizaster into three genera, following the three types of the Catalogue Raisonné; he has, however, retained for S. atropos the name of Schizaster, and separated the closely allied species S. canaliferus and S. gibberulus, placing them respectively in the genera Brisaster and Nina. The subdivisions of Michelin made at the same time, more in accordance with the affinities of the species, are retained here. To distinguish this genus from the same generic name previously used by Leach and Huebner, I have changed the name to **Moira**:—

Moira atropos

! *Spatangus* **atropos** Lamk. 1816. An. s. V.
! **Moira** *atropos* A. Agass. 1872. Rev. Ech. Pt. I.

Pl. XXIII.

Outline from above elliptical (*Pl. XXIII. f. 1, 5*); when denuded of spines, slightly angular near junction of interambulacral plates. The plates of test are all somewhat conical (*Pl. XIII. f. 6*), resembling shield plates of turtles rising slightly towards one side and tapering towards the edge; from their highest point the tubercles radiate irregularly towards the edge. The angular outline increases greatly with age, and in older specimens this feature becomes quite prominent, while in younger specimens the tendency is to be more and more ovoid. Part of the posterior edge of the apical part of the anterior ambulacra projects over the anterior edge, completely closing the upper portion of the anterior lateral ambulacra (*Pl. XXIII. f. 5*). It then recedes again, and the ambulacral groove thus appears to commence at a distance from the apex and make a marked angle with the longitudinal axis.

The odd anterior ambulacrum is divided, by the closing up of the slightly sunken edge of the abactinal part of the edge of the anterior groove, into two connected cavities. When seen from above, the projecting lips form two triangular spaces (*Pl. XXIII. f. 5*), closely covered by small tubercles, to the anterior edge of which the peripetalous fasciole extends, and then passes on to the edge of the lateral ambulacra. The anterior lateral ambulacra are much longer than the posterior. The vertex is situated slightly behind the apical system; the posterior extremity is truncated vertically, making a sharp angle with the actinal plastron, which has, immediately below the subanal fasciole, a small, fully developed keel (*Pl. XXIII. f. 4*). The anal system is flush with the test, small, elliptical, edged by eight large plates surrounding the smaller interior ones. The lateral fasciole is narrow, becoming slightly broader under the anal system; the part of fasciole adjoining the deep groove is broad; the connecting parts between the petals are narrow. Seen in profile, the anterior edge is gradually rounded from the vertex to the ambitus, the same curve of the test extending to the mouth (*Pl. XXIII. f. 2*).

Fragments of this species were dredged from a depth of 80 fathoms. Girard has attempted to separate specimens from Texas, of slightly more elongate outline, as a distinct species. The color of M. atropos when alive is yellowish. The spines, where more thickly clustered, are brownish; they are short except where they cover the sunken ambulacra, which are entirely hidden by the longer spines meeting from both sides. On the lower surface, the interambulacral plastron is covered by long spines, which, as they wear out at the extremity, become spatula-shaped. On the side of the ambitus, and on the upper lateral part of the posterior ambulacra, the spines attain a greater length, especially towards the mouth, where they are most closely crowded together.

Littoral to 80 fathoms.

Longitudinal Diameter.	Transverse Diameter.	Height.	Length Posterior Ambulacra.	Length Anterior Ambulacra.	Distance of Lip Anterior Amb. from Vertex.	Height of Anus above Actinal Surf.
47.	44.	37.5	14.2	24.8	10.1	14.
42.	42.	31.2	13.0	21.	8.8	11.8
30.6	30.5	26.	10.0	18.	6.	8.9
22.5	21.	18.2	7.0	13.	5.	8.

BATHYMETRICAL AND GEOGRAPHICAL DISTRIBUTION.

THE accompanying table (pp. 368 and 369) shows at a glance the principal features of distribution of the different zones of depth. We can distinguish a strictly littoral fauna, extending from tide-mark to generally less than 10 fathoms, though a few of the species characteristic of this zone extend to a depth of 34 and 40 fathoms. This fauna consists of

Diadema setosum.
Echinometra subangularis.
Echinometra viridis.
Toxopneustes variegatus.
Hipponoë esculenta.
Echinanthus rosaceus.
Clypeaster subdepressus.
Mellita testudinata.
Encope Michelini.
Encope emarginata.
Echinonëus semilunaris.
Brissus unicolor.

A second set of species, less numerous, extends from the shore to a much greater depth, — from 80 to about 120 fathoms. They are

Cidaris tribuloides.
Arbacia punctulata.
Meoma ventricosa.
Metalia pectoralis.
Moira atropos.

At a depth of from 30 to 40 fathoms commences a third set of species, the majority ranging to about 160 fathoms, though two species range to 270 fathoms (marked *), and a few species commence at a greater depth, 80 to 90 fathoms. These species are

* Dorocidaris papillata.
Echinus gracilis.
Temnechinus maculatus.
* Trigonocidaris albida.
Rhynchopygus caribaearum.
Echinolampas depressa.
Neolampas rostellata.
Brissopsis lyrifera.
Agassizia excentrica.
Echinocardium flavescens.
Echinocardium pennatifidum.
Echinocardium cordatum.
Schizaster fragilis.

NOTE. — Figures denote depth in fathoms; range of a species is indicated by the horizontal lines; thus, 138——270 in Hemipedina shows its range from 138 to 270 fathoms. Figures at head of column to be taken, where no others are given.

	Lit.	10	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380
Cidaris tribuloides BL.								116													
Dorocidaris *papillata* A. AGASS.																270					
Salenia varispina A. AGASS.																		315			
Diadema setosum GRAY.			17																		
Asthenosoma hystrix A. AGASS.									138												
Hemipedina cubensis A. AGASS.									138							270					
Arbacia *punctulata* GRAY.									125												
Podocidaris sculpta A. AGASS.									138									315			
Coelopleurus **floridanus** A. AGASS.										160											
Echinometra subangularis DESML.	7																				
Echinometra **viridis** A. AGASS.	7																				
**Strongylocentrotus Dröbachiensis* A. AGASS.																					
Echinus **gracilis** A. AGASS.							93														
Echinus **norvegicus** D. K.												195									
Temnechinus maculatus A. AGASS.			30																		
Trigonocidaris albida A. AGASS.																270					
Toxopneustes variegatus A. AGASS.				34																	
Hipponoë esculenta A. AGASS.																					
Echinanthus rosaceus GRAY.	5																				
Echinocyamus pusillus GRAY.																			325		

* Not a Florida species.

	Lit.	10	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380
Clypeaster subdepressus A. Agass.	—	—	—	34																	
**Echinarachnius parma* Gray.	—	—	—	40																	
Mellita testudinata Klein.	—7																				
Mellita sexforis Agass.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	270					
Encope **Michelini** Agass.		11																			
Encope emarginata Agass.	—7																				
Echinonëus semilunaris Lam.	—																				
Echinolampas **depressa** Gray.				35	—	—	—	—	—	160											
Rhynchopygus caribaearum Lütk.						106															
Neolampas rostellata A. Agass.							—	—	125												
Pourtalesia miranda A. Agass.																				349	
Homolampas *fragilis* A. Agass.																		—	—	—	368
Brissus unicolor Kl.	—																				
Meoma ventricosa Lütk.	—	—	—	—	—	—	85	115													
Metalia pectoralis A. Agass.	—	—	—	—	—	—	—	—	—	156											
Brissopsis lyrifera Agass.				55	—	—	—	115													
Agassizia **excentrica** A. Agass.			36	—	—	—	—	—	128												
Echinocardium flavescens A. Agass.						79	—	—	121												
Echinocardium **pennatifidum** Norm.						79	—														
Echinocardium cordatum Gray.	—	—	—	—	—	—	85														
Schizaster fragilis Agass.						—															
Moira *atropos* A. Agass.	—	—	—	—	—																

* Not a Florida species.

At a depth of about 140 fathoms, extending to over 310 fathoms, are found most interesting species: —

Hemipedina cubensis.	Echinus norvegicus.
Podocidaris sculpta.	

While near the lowest depth reached by the above species we strike upon a peculiar fauna recalling types of the cretaceous period, extending from 315 fathoms to the greatest depth attained in the straits between Florida and Cuba. These are

Salenia varispina.	Homolampas fragilis.
Pourtalesia miranda.	

Two species — Echinocyamus pusillus and Mellita sexforis — have the greatest bathymetrical range, extending from the shore, the one to 270 fathoms and the other to 325 fathoms. I would state, however, that it is only the young which have this great range; the adult specimens are limited to a quite shallow zone, — about 40 fathoms. In the young of our common northern Cuvieria the reverse takes place, the young being quite common at low-water mark, while young Echinarachnius and S. Dröbachiensis are found at a much greater depth than the adult.

I have given the greatest depth of living young, as the dead tests may have been dropped by fishes or carried by currents. The character of the Echinian fauna, on the three belts developed by the soundings of Mr. Pourtalès, are tolerably well defined; the first zone being littoral, and extending to 90 fathoms, is characterized by species, the majority of which do not range beyond 40 fathoms, with a few species ranging somewhat beyond, to about 120 fathoms.

The second zone (from 90 to 250 fathoms) is characterized by species extending into the first somewhat, and attaining a range of about 270 fathoms, with an admixture of a few species extending from 140 to 310 fathoms.

The third zone contains the typical deep-sea species of Florida, extending from 315 to 500 fathoms.

Although we have not a sufficient number of soundings to establish homogeneous zones of geographical and bathymetrical range, an analysis of the above grouping of species shows us something analogous to the distribution of animal and vegetable life in latitude and height; the oceanic distribution

being of course an identity for northern latitudes and southern depth, or a representation by species closely allied.

For instance, we find littoral, as far north as North Carolina, Moira atropos and Echinocardium cordatum; Arbacia punctulata, as far north as the southern part of Cape Cod, species which in Florida have a range in depth to 125 fathoms. Of their bathymetrical range farther north we know nothing.

The following North European species, Dorocidaris papillata, Schizaster fragilis, Echinus norvegicus, Echinocardium flavescens, E. cordatum, Echinocyamus pusillus, Brissopsis lyrifera, Asthenosoma hystrix, are found in Florida. These same species, with the addition of Brissus unicolor, Echinocardium pennatifidum, Diadema setosum, and Arbacia punctulata, are again the representatives of a Mediterranean fauna strikingly similar, consisting of Schizaster canaliferus, Echinus melo, Echinocardium mediterraneum, Centrostephanus longispinus, Arbacia pustulosa. The specific representation on both sides of the Isthmus of Panama is becoming every day, as far as Echinoderms are concerned, more strikingly identical. Since the list given by Mr. Verrill, several species have come to light, and the following comparative list (p. 372) of species on both sides of the Isthmus, extending from Peru to the Gulf of California on the Pacific, and including on the eastern side the Gulf of Mexico, Florida, the northern coast of South America, the West Indies, and the Bahamas, may not be out of place. (I have examined all the species there named.) As this list will undoubtedly be greatly increased by additional dredging from the Hassler Expedition, it is given as published in the Preliminary Report, and no attempt has been made to re-examine the question of the specific identity of any of the Echini on the Atlantic and Pacific sides of the Isthmus of Panama.

With the exception of three Panama species, all the West Coast species have representatives on the Eastern Coast. The Eastern species which have not as yet been found represented on the West Coast are the deep-water species of Mr. Pourtalès's collection, and, what is very peculiar, three species, Echinonëus semilunaris, Echinocardium cordatum, and Echinolampas, belonging to genera which have a most extensive range.

The relation of the Caribbean fauna to the existing geographical distribution of Echini is shown by the accompanying faunal table, page 373, and the maps of Part I. *Plates A – G.*

Eastern Side. (*Tropical Atlantic.*)	Western Side. (*Panamic*).
Cidaris tribuloides Bl.	*Cidaris* **Thouarsii** Val.
Dorocidaris *papillata* A. Agass.	
Salenia varispina A. Agass.	
Diadema setosum Gray.	*Diadema* **mexicanum** A. Agass.
	Astropyga pulvinata Agass.
Asthenosoma hystrix A. Agass.	
Hemipedina cubensis A. Agass.	
Arbacia *punctulata* Gray.	**Arbacia** *stellata* Gray.
Podocidaris sculpta A. Agass.	
Coelopleurus **floridanus** A. Agass.	
Echinometra subangularis Desml.	*Echinometra* **Van Brunti** A. Agass.
Echinometra **viridis** A. Agass.	
	Strongylocentrotus mexicanus A. Agass.
Echinus **gracilis** A. Agass.	
Echinus **norvegicus** D. & K.	
Temnechinus maculatus A. Agass.	
Trigonocidaris albida A. Agass.	
Toxopneustes variegatus A. Agass.	*Toxopneustes semituberculatus* A. Agass.
	Toxopneustes *pileolus* Agass.
Hipponoë esculenta A. Agass.	*Hipponoë depressa* A. Agass.
Echinanthus rosaceus Gray.	*Echinanthus* **testudinarius** Gray.
Clypeaster subdepressus Agass.	*Clypeaster rotundus* A. Agass.
Echinocyamus pusillus Gray.	
Mellita testudinata Kl.	*Mellita* **longifissa** Mich.
Mellita sexforis A. Agass.	*Mellita* **pacifica** Verrill.
	Mellita Stokesii A. Agass.
	Encope **californica** Verrill.
Encope **Michelini** Agass.	**Encope grandis** Agass.
Encope emarginata Agass.	*Encope* **micropora** Agass.
Echinoneus semilunaris Lam.	
Echinolampas **depressa** Gray.	
Rhynchopygus caribaearum Lütk.	*Rhynchopygus pacificus* A. Agass.
Neolampas rostellata A. Agass.	
Pourtalesia miranda A. Agass.	
Homolampas *fragilis* A. Agass.	
	Lovenia **cordiformis** Lütk.
Brissus unicolor Kl.	*Brissus* **obesus** Verrill.
Meoma ventricosa Lütk.	**Meoma grandis** Gray.
Metalia pectoralis A. Agass.	*Metalia maculosa* A. Agass.
Brissopsis lyrifera Agass.	
Agassizia **excentrica** A. Agass.	**Agassizia scrobiculata** Val.
Echinocardium flavescens A. Agass.	
Echinocardium **pennatifidum** Norm.	
Echinocardium cordatum Gray.	
Schizaster fragilis Agass.	
Moira *atropos* A. Agass.	**Moira** *clotho* A. Agass.

EASTERN SIDE OF ISTHMUS. (*Tropical Atlantic.*)	Panamic.	North Atlantic.	Lusitanian.	West African.	Indo-Pacific.	Japanese.	Patagonian.
Cidaris tribuloides Bl.	*			*i*	*		
Dorocidaris *papillata* A. Agass.		*i*	*i*		*		*
Salenia varispina A. Agass.							
Diadema setosum Gray	*	*i*	*i*	*i*	*i*		
Asthenosoma hystrix A. Agass.		*i*	*i*			*	
Hemipedina cubensis A. Agass.						*	
Arbacia *punctulata* Gray	*		*i*	*i*			*
Podocidaris sculpta A. Agass.							
Coelopleurus **floridanus** A. Agass.					*		
Echinometra subangularis Desml.	*		*i*	*i*	*	*	
Echinometra **viridis** A. Agass.					*		
Echinus **gracilis** A. Agass.		*	*				
Echinus **norvegicus** Düb. o. Kor.		*i*	*i*				*
Temnechinus maculatus A. Agass.			*i*			*	
Trigonocidaris albida A. Agass.						*	
Toxopneustes variegatus A. Agass.	*				*		
Hipponoë esculenta A. Agass.	*				*	*	
Echinanthus rosaceus Gray	*				*	*	
Clypeaster subdepressus Agass.	*			*	*	*	
Echinocyamus pusillus Gray		*i*	*i*				
Mellita testudinata Kl.	*						
Mellita sexforis A. Agass.	*				*?		
Encope **Michelini** Agass.	*						
Encope emarginata Agass.	*						
Echinoneus semilunaris Lam.					*		
Echinolampas **depressa** Gray				*	*		
Rhynchopygus caribaearum Lütk.	*						
Neolampas rostellata A. Agass.							
Pourtalesia miranda A. Agass.		*i*	*i*				
Homolampas *fragilis* A. Agass.			*i*				
Brissus unicolor Kl.	*		*i*		*i*	*i*	
Meoma ventricosa Lütk.	*						
Metalia pectoralis A. Agass.	*			*	*	*	
Brissopsis lyrifera Agass.		*i*	*i*		*		*
Agassizia **excentrica** A. Agass.	*						
Echinocardium flavescens A. Agass.		*i*	*i*				
Echinocardium **pennatifidum** Norm.		*i*	*				
Echinocardium cordatum Gray		*i*	*i*			*	
Schizaster fragilis Agass.		*i*	*		*		
Moira *atropos* A. Agass.	*				*		

Note. — *i* denotes identity of species; * denotes representative species.

We have in Temnechinus maculatus and Trigonocidaris albida representatives of the Temnopleuridae, thus far limited almost entirely to the Indian and China Seas. The littoral species having the most limited bathymetrical range are those which have the widest geographical distribution. They are Diadema setosum, Cidaris tribuloides, Clypeaster subdepressus, Echinometra subangularis, Toxopneustes variegatus, Mellita testudinata, Encope emarginata. Some of these species extend from the southern part of Brazil to the Bermudas. They all belong to genera having representatives in the great tropical belt surrounding the globe, formed by the Indo-Pacific, Lusitanian, West African, Tropical Atlantic, and Panamic districts, — such as Cidaris, Diadema, Echinometra, Hipponoë, Clypeaster, Echinanthus, Echinolampas, Echinonëus, Brissus, — the species of which have a great geographical range, and are represented by the following species: Cidaris metularia, Hipponoë variegata, Echinometra lucunter, Diadema setosum, Clypeaster humilis, Echinolampas oviformis, Echinonëus cyclostomus, Brissus carinatus; all of which have an immense geographical distribution.

The precise range of the different species of the East Coast will be found in Part I., in the Synonymy and in the General Lists of the Geographical Distribution.

SYSTEMATIC TABLE

OF THE ECHINI OF THE EASTERN COAST OF THE UNITED STATES.

Suborder DESMOSTICHA, HAECKEL.

Family **CIDARIDAE**, MÜLL.

Subfamily **GONIOCIDARIDAE**, HAECKEL.

Cidaris KLEIN.
Cidaris tribuloides BL., 253.

Dorocidaris A. AGASS.
Dorocidaris *papillata* A. AGASS., 254.

Subfamily **SALENIDAE**, AGASS.

Salenia GRAY.
Salenia varispina A. AGASS., 261.

Family **ARBACIADAE**, GRAY.

Arbacia GRAY.
Arbacia *punctulata* GRAY, 263.

Coelopleurus AGASS.
Coelopleurus **floridanus** A. AGASS., 267.

Podocidaris A. AGASS.
Podocidaris sculpta A. AGASS., 269.

Family **DIADEMATIDAE**, PET.

Asthenosoma GRUBE.
Asthenosoma hystrix A. AGASS., 272.

Diadema SCHYNV.
Diadema setosum GRAY, 274.

Family **ECHINOMETRADAE**, GRAY.

Strongylocentrotus BR.
Strongylocentrotus Dröbachiensis A. AGASS., 277.

Echinometra ROND. (BREYN.).
Echinometra subangularis DESML., 283.
Echinometra **viridis** A. AGASS., 284.

Family **ECHINIDAE**.

Subfamily **TEMNOPLEURIDAE**, DES.

Temnechinus FORBES.
Temnechinus maculatus A. AGASS., 286.

Trigonocidaris A. AGASS.
Trigonocidaris albida A. AGASS., 289.

Subfamily **TRIPLECHINIDAE**, A. AGASS.

Hemipedina WRIGHT.
Hemipedina cubensis A. AGASS., 291.

Echinus ROND. (LINN.).
Echinus **gracilis** A. AGASS., 293.
Echinus **norvegicus** D. o. K., 296.

Toxopneustes AGASS.
Toxopneustes variegatus A. AGASS., 298.

Hipponoë GRAY.
Hipponoë esculenta A. AGASS., 301.

Suborder CLYPEASTRIDAE, AGASS.

Family **EUCLYPEASTRIDAE**, HAECKEL.

Subfamily **FIBULARINA**, GRAY.

Echinocyamus VAN PHEL.
Echinocyamus pusillus GRAY, 304.

Subfamily **ECHINANTHIDAE**, A. Agass.

Clypeaster Lamk.
Clypeaster subdepressus Agass., 306.

Echinanthus Breyn.
Echinanthus rosaceus Gray, 311.

Family **SCUTELLIDAE**, Agass.

Echinarachnius Leske.
Echinarachnius parma Gray, 316.

Mellita Klein.
Mellita sexforis A. Agass., 320.
Mellita testudinata Kl., 322.

Encope Agass.
Encope emarginata Agass., 325.
Encope **Michelini** Agass., 329.

Suborder PETALOSTICHA, Haeckel.

Family **CASSIDULIDAE**, Agass.

Subfamily **ECHINONIDAE**, Agass.

Echinonëus Van Phel., 332.
Echinonëus semilunaris Lamk., 333.

Subfamily **NUCLEOLIDAE**, Agass.

Echinolampas Gray.
Echinolampas depressa Gray, 335.

Neolampas A. Agass.
Neolampas rostellata A. Agass., 340.

Rhynchopygus D'Orbig.
Rhynchopygus caribaearum Lütk., 343.

Family **SPATANGIDAE**, Agass.

Subfamily **ANANCHYTIDAE**, Alb. Gras.

Pourtalesia A. Agass.
Pourtalesia miranda A. Agass., 345.

Homolampas A. Agass.
Homolampas *fragilis* A. Agass., 348.

Subfamily **SPATANGINA**, Gray.

Echinocardium Gray.
Echinocardium cordatum Gray, 349.
Echinocardium flavescens A. Agass., 351.
Echinocardium **pennatifidum** Norm., 351.

Subfamily **BRISSINA**, Gray.

Agassizia Val.
Agassizia **excentrica** A. Agass., 353.

Brissopsis Agass.
Brissopsis lyrifera Agass., 354.

Brissus Klein.
Brissus unicolor Klein, 357.

Meoma Gray.
Meoma ventricosa Lütk., 358.

Metalia Gray.
Metalia pectoralis A. Agass., 361.

Schizaster Agass.
Schizaster fragilis Agass., 363.

Moira A. Agass.
Moira *atropos* A. Agass., 365.

INDEX

OF THE ECHINI OF THE EASTERN COAST OF THE UNITED STATES, DESCRIBED IN PART II.*

* The Synonymic Index, Part I., will give the references of the Synonymes to the names adopted here.

ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. VII.

REVISION OF THE ECHINI.

BY

ALEXANDER AGASSIZ.

PART III.

WITH FORTY-FIVE PLATES.

UNIVERSITY PRESS, CAMBRIDGE,
WELCH, BIGELOW, & CO.
1873.

PART III.

DESCRIPTION OF THE SPECIES OF RECENT ECHINI.

WITH TWENTY-EIGHT PLATES.

NOTICE.

THE third and fourth Parts of the Revision were to have been issued simultaneously. Owing, however, to the destruction, in the great conflagration of November 9, 1872, of the lithographic stones of six of the Plates of Part IV., together with the original drawings, and all the MS. Notes on the subject, Part III. is issued in advance, with the Plates belonging to Part IV., in order not to delay the publication of the mere descriptive Part (Part III.).

It was impracticable to refer in Part III. to publications which have appeared since the issue of Parts I. and II. not included in the Bibliography and Synonymy, as the greater portion of the descriptions of Part III. has been in type for some time.

In Part III. no reference has been made in some of the specific descriptions to a few plates which were not struck off at the time the descriptions were printed. This is not of great importance, as the plates referred to were intended to illustrate general points of structure. A complete Index of the contents of the Plates is given to obviate this defect.

ALEXANDER AGASSIZ.

CAMBRIDGE, September, 1873.

DESMOSTICHA.

Suborder **Desmosticha** HAECKEL, Entwickel. Gesch., 1866. (emend.)

THE order of Desmosticha contains the so-called Regular Echini of Albin Gras, the Endocycla of Wright. The Echini belonging to this order are all more or less circular in outline. The anal system is surrounded and completely enclosed by the genital and ocular plates. The actinostome is central. The poriferous zone is composed of pairs of pores, extending from the abactinal system to the actinostome, either as simple vertical rows or forming numerous disconnected arcs. The jaws are highly developed and quite complicated, supported upon prolongations (auricles) of the ambulacral or interambulacral plates of the edge of the actinostome, which may be connected to form either arches or disconnected supports. A longitudinal axis is indicated by the position of the madreporic body. The Desmosticha, compared with the Perischoechinidae, differ in having only ten double rows of ambulacral and interambulacral plates, five called ambulacral and five interambulacral. As far as known, they are all provided with branching gills extending through openings of the coronal edge of the buccal membrane, corresponding to cuts more or less marked in the outline of the test of the actinal system. The digestive system is a simple alimentary canal, arising above the jaws, suspended in a cavity, like a thin band, by mesenteries attached to the interambulacral system, arching over the ambulacral system. The ovaries in the breeding-season are large, they nearly fill the whole space not occupied by the digestive system. Stone canal well developed. Ambulacral tentacles pointed or provided with suckers. With the exception of the auricles for the support of the jaws and the madreporic funnel of the stone canal, there are no pillars or partitions of any kind in the interior of the test. Actinal system covered by a flexible buccal membrane attached to jaws. Actinostome opening within the teeth, and leading directly to the small part of the alimentary canal.

The tubercles carrying the spines form vertical or horizontal rows on the ambulacral and interambulacral plates. The spines are comparatively large compared to the size of the test, and less numerous than in the other suborders of recent Echini.

CIDARIDAE.

Family **Cidaridae** MÜLLER, Bau d. Echinod., 1854. (emend.)

GONIOCIDARIDAE.

Subfamily **Goniocidarida** HAECKEL, Entwickel. Gesch., 1866.

Although the Cidaridae proper had been separated as a group from the Echinidae and Salenidae by Agassiz and Desor, yet Müller was the first to analyze more in detail their structure, and to separate the family Cidaridae from the Echinidae He showed, in addition to the large number of small plates composing the ambulacral area, composed of single pairs of pores arranged in a narrow vertical zone (except in a single fossil genus, Diplocidaris), the great width of the interambulacral region, the small number of the coronal plates of the interambulacral region, each surmounted with but a single primary perforate tubercle, surrounded by a large scrobicular circle more or less prominent, that the poriferous zone extended to the buccal edge of the imbricated buccal membrane; that the actinal cuts were not in the coronal plates, but near the actinostome in the edge of the buccal membrane. The actinal and abactinal system are both large and of nearly the same size. The primary interambulacral spines are large, while those of the ambulacral system and of the miliary zone are small flattened papillæ, and never ornamented; the papillæ extend over the buccal membrane. The jaws are less complicated than in the Echinidae and Diadematidae. The teeth are in shape of a gauge, like those of the Diadematidae; and the auricles, made up of independent arches, take their origin from the interambulacral instead of the ambulacral spaces. The jaws have not the large triangular foramen of the Echinidae, nor are the sides of the jaws connected over their central part.

CIDARIS.

Cidaris KLEIN, 1734, Nat. Disp. Echin. (See Part II., p. 252.)

The structure of the spines is different from that of the other Echinidae. A section shows the shaft to be made up of irregularly arranged small limestone cells, closely packed, surrounded by an outer sheath of limestone network, which forms the ornamentation of the spines and grows independently of the inner structure.

Cidaris metularia

! *Cidaris metularia* Blainv., 1830, Zooph.
! *Cidarites* **metularia** Lamk., 1816, An. s. Vert.

Pl. I^c. f. 23, 24; Pl. I^g. f. 1; Pl. XXXV. f. 3.

Abactinal system sparsely covered by minute miliary spines and small pedicellariæ mounted upon brilliant glassy tubercles. A ring of larger miliaries surmounted by spines surrounds the whole abactinal system. Genital plates large, trapezoidal in contact; anal system pentagonal, one row of large plates on side next madreporic body; ocular plates triangular. In the ambulacra the outer rows of secondary tubercles adjoining the poriferous zone are large, with two inner vertical rows of small miliaries, well defined, extending along the ambulacral zone. The median interambulacral space filled with broad flat miliary tubercles, with indistinct mammary boss, in striking contrast to the prominent secondary tubercles surrounding the small scrobicular circle of the primary interambulacral tubercles. The striation of the spines is fine; the granulation exceedingly coarse, especially in young specimens; granules distant. The spines are more frequently colored by transverse bands than either in C. tribuloides or C. Thouarsii. The color of the secondaries and papillæ is light violet, darker at tip, those of the ambulacral region usually darker than the interambulacral secondaries and papillæ. The median interambulacral zone of C. metularia is much narrower than the corresponding zone of specimens of the same size of C. tribuloides.

Red Sea; Mauritius; East India Islands; Sandwich Islands; Feejee Islands.

Cidaris Thouarsii

! *Cidaris* **Thouarsii** Val., 1846, Ag. Des. C. R. Ann. Sc. Nat., VI.

Pl. I^c. f. 1–5^b; Pl. XXXV. f. 2; Pl. XXXVIII. f. 1, 2.

Genital plates elongate, tapering; genital openings large, only partly covered by miliaries; outer edges of plates adjoining anal system bare; plates of anal system much smaller than in C. tribuloides, extending towards the ocular plates, forming a stelliform abactinal system; the genital plates completely separated by a large anal plate projecting between them from the anal system. Ocular plates elongate, smaller than in C. tribuloides.

Ambulacra narrower than in C. tribuloides, with a single irregular vertical row of small miliaries between the two exterior main rows. The principal interambulacral tubercles separated by a narrow zone of miliaries of nearly the same size as the secondaries forming the large scrobicular circle. The

mammary boss of the primaries is much larger than in C. tribuloides; the primary spines are larger and stouter, in proportion to the size of test, than in the West India species, the granulation coarser; the secondary spines and miliary papillæ are dark violet, and narrower than the corresponding spines of the West India species. The granulation of the spines frequently appears late; they are then longitudinally striated and pointed.

There are usually but two miliaries on the imbricating perforated scales of the buccal membrane.

In large specimens the median ambulacral zone is filled by six irregular vertical rows of minute miliaries. The primary interambulacral tubercles of the main vertical row are far apart. The median interambulacral space is completely filled by minute miliaries, increasing in size towards the primary tubercles, carrying small papillæ arranged in irregular transverse horizontal rows separated by more or less well-marked furrows. These large specimens of Thouarsii are mentioned by Dr. Lütken and by Prof. Verrill in his Notes on Radiata as a new species of Cidaris from the Gulf of California.

Panama; Gulf of California.

Cidaris tribuloides

! *Cidarites* **tribuloides** LAMK., 1816, An. s. Vert.
! *Cidaris tribuloides* BLAINV., 1830, Zooph.
(See Part II. p. 253.)

Pl. I

Pl. I^c.; Pl. I. f. 18–22; Pl. II. f. 1–3; Pl. II

Florida; Brazil; Cape Palmas.

(CIDARIS.) DOROCIDARIS.

Orthocidaris (**A. Ag.**), 1863, non Cotteau.
Dorocidaris A. AGASS., 1869, Bull. M. C. Z., I.
(See Part II. p. 254.)

Dorocidaris papillata

Cidaris **papillata** LESKE, 1778, KL. Add.
! **Dorocidaris** *papillata* A. AGASS., 1869, Bull. M. C. Z., I.
(See Part II. p. 254.)

Pl. I.; Pl. I^b.; Pl. I^c. f. 25–33; Pl. II^a. f. 1–13; Pl. II^b. f. 1–5; Pl. II^c. f. 13–15; [Pl. XXIV. f. 1–8.

Norway; Mediterranean; Florida.

(CIDARIS.) Phyllacanthus.

Phyllacanthus Brandt, 1835, Prod. Desc. An.

Brandt was the first to separate Cidaris into two sections, distinguished, it is true, by the rather meagre character of straight and flexuous poriferous zones. Yet the species he mentions as belonging to his two sections correspond so well to the modifications subsequently introduced by Desor, that we cannot help retaining his subdivision. Desor has separated as Rhabdocidaris (crenulate tubercles, fossil) and Leiocidaris (no crenulation, recent), the fossil and recent species, — a character which he has not adopted as of generic value in Cidaris proper; and there appears to be, at present at least, no reason for assuming this feature to have any great value.

Test swollen, comparatively thinner, and with a larger number of coronal plates than in Cidaris. Ambulacra almost straight or very slightly undulating. The poriferous zone is broad, the pores of a pair connected by a slight horizontal furrow. The primary spines vary greatly in shape, — cylindrical, triangular, flattened, club-shaped, elongate, fluted; granulation longitudinal, often forming highly developed lamellæ or simply close longitudinal striæ, or rows of secondary spines. Tubercles perforate, mammary boss smaller than in Cidaris; scrobicular circle large, with very prominent granules; areola deeply sunken.

Phyllacanthus annulifera

! *Cidarites* **annulifera** Lam., 1816, An. s. V.
! *Phyllacanthus annulifera* A. Ag., 1872, Rev. Ech., Pt. I. p. 150.

Pl. V. f. 21–26a.

Genital plates separated from the large triangular ocular plates by bare sutures. Genital openings large, near outer edge of plates. Miliaries covering the abactinal system distant and confined to central part in ocular plates. Anal plates of nearly uniform size, each plate carrying but two or three miliaries. Anal plates encroaching between the genital plates. Median ambulacral space narrow, with two vertical rows of miliaries between the two external rows of secondary tubercles. Median interambulacral space narrow, with but few small miliaries in addition to secondaries; median sutural line well marked. Scrobicular circle very distinct, formed by a double row of secondary tubercles.

Secondary spines and papillæ elongate, tapering, yellowish, with greenish longitudinal stripe in middle. Primary spines nearly twice the diameter of the test, gradually tapering towards extremity, often fluted, cupuliform; granulation in irregular longitudinal rows, with scattered larger spines along body of shaft. Spines greenish, ringed with alternate bands of violet and yellow. Test thin, somewhat compressed; the general facies is similar to Dorocidaris papillata.

Australia; Philippine Islands.

Phyllacanthus baculosa

! *Cidarites* **baculosa** LAM., 1816, An. s. Vert.
! *Phyllacanthus baculosa* A. AG., 1872, Rev. Ech., Pt. I. p. 150.

Pl. I^F. f. 4, 5; Pl. I^c. f. 34–38; Pl. I^e. f. 11–20^a; Pl. XXIV. f. 9; Pl. XXXV. f. 4.

In all species of Phyllacanthus the normal number of primary tubercles is early developed; this number, rarely exceeding eight in each vertical row, is already attained in specimens measuring $37^{mm.}$, and the number is not greater in specimens of double the size, even in this species, which is the one of the genus where the primary tubercles are most numerous, being smaller and more closely packed together than is usually the case in the other species of the genus.

The median interambulacral space is very broad, scantily covered by minute miliaries carrying small papillæ; so that this median space, even in specimens covered with all their primary and secondary spines, has a very denuded appearance. The scrobicular circle is elongate, elliptical, surrounded by secondary tubercles, and less prominent than in species of this genus, as the horizontal divisions between adjoining circles disappear almost entirely, owing to the great reduction in the size of the dividing miliaries and secondaries. The mammary boss of the primary tubercles is small, but little prominent. The median ambulacral space is broad, with four well-defined and well-separated vertical rows of miliaries placed within the two outer rows of secondary tubercles forming the edge of this region. Two of the inner rows are placed close to the outer rows of secondaries, the other two inner rows are placed close together in the middle of the ambulacral region.

The genital plates are nearly of uniform size, the madreporic plate only slightly largest; genital openings are situated one third the length of plate from outer edge. Ocular plates very large, trapezoidal; ocular openings small,

whole surface of abactinal system sparsely covered by miliaries. One row of large plates round the anal system extending between the genital plates to ocular plates; interior plates of anal system irregular in shape, few in number, diminishing gradually in size towards anal opening.

Secondary spines and papillæ long. Primary spines extremely variable in shape, from flattened, spindle-shaped spines with serrated edges, slender at base and pointed at extremity, to a uniformly tapering cylindrical shaft with regular longitudinal rows of granulation. The character of the spines gives such a different appearance to specimens that it is not remarkable that many species should have been based upon features of such striking character; the only figures we possessed, that of Savigny and that of Michelin, of the two extremes, naturally only strengthening the belief in the validity of the differences noticed. A remarkably fine series of the variations of this species, due to the changeable nature of the spines, exists in the Stuttgart Museum; the only positive character of permanence being the spotted base of the shaft of the spine below the milled ring, which is of a light reddish or reddish-yellow ground-color, with deep violet spots marked extremely distinctly upon the fine longitudinal striation. No matter what might be the structure of the spine, the groundwork of granulation remained the same, and could be distinctly traced either when the primary spines were ornamented by thick lamellæ running longitudinally, or were irregularly covered by short spines, or were spindle-shaped with serrated edges, or simply cylindrical shafts, slightly fluted.

Red Sea; Mauritius; Zanzibar.

Phyllacanthus dubia

Phyllacanthus dubia Br. 1835, Prod. Des. An.

Pl. I^c. f. 39; Pl. I^e. f. 7–10; Pl. I^f. f. 1, 2.

This species is extremely closely allied to P. imperialis, but better series of specimens than those thus far collected may yet show the identity of this species with P. imperialis. The geographical range of the two species is nearly identical; the characters enumerated below have, however, been found to be permanent.

Genital openings large, on the very outer edge of the genital plate, placed in a well-marked groove; granulation of abactinal system coarse; ocular plates smaller, and plates of anal system larger and less numerous than in P. imperialis.

Median ambulacral zone narrow, with two exterior rows of coarse tubercles and two median irregular rows of smaller alternating tubercles. The narrowness of the median ambulacral field distinguishes this species from P. imperialis, as well as the coarser character of the miliaries filling the median interambulacral space. In the smallest specimens examined of P. imperialis, the greater width of the median ambulacral zone, the number of vertical rows of miliary tubercles in the median interambulacral space, and the nature of the granulation were already well marked, as differing from P. dubia; so that, in consequence of the coarser granulation of the secondary and miliary tubercles, the ambulacral and interambulacral papillæ which they carry are broader, as well as those surrounding the base of the primary spines.

This species, when not denuded, can apparently be readily distinguished from its allied congener even when covered with its spines. The primary spines are nearly cylindrical, sometimes slightly swelling near base, or gently tapering towards the extremity; they are deeply grooved for their whole length. The granulation forming the lamellæ is extremely compact, the whole interlamellular space is extremely porous; while in P. imperialis the granulation is most distinct, and the texture of the cylindrical or bat-shaped spine homogeneous and solid.

The color of the secondary spines and papillæ is violet; the porous part of shaft of spine is grayish, with darker-colored longitudinal lamellæ of violet or bluish tinge. The base of spine is reddish-brown, the milled ring prominent; the spine tapers from the milled ring to the commencement of the fluting, the line of demarcation between the shaft of the spine and annular ring at base of spine, above milled ring, being very marked.

Zanzibar; Bonin Islands; Australia.

Phyllacanthus gigantea

! **Chondrocidaris gigantea** A. Ag., 1863, Bull. M. C. Z.
! *Phyllacanthus gigantea* A. Ag., 1872, Rev. Ech., Pt. I. p. 150.

Pl. I[a]; Pl. I[c]. f. 27–31.

Only three large specimens of this species have been accessible to me. The primary interambulacral tubercles are ten in number, the greatest number thus far noticed in any species of Phyllacanthus and Cidaris proper. The scrobicular circle is elongated, the median interambulacral space covered by miliaries is more than half the total breadth of the interambulacral zones. The miliaries are densely packed, of uniform size, and carrying very short

papillæ; hence the bare appearance of this region even when the test is not denuded. The secondaries forming the scrobicular circle are not large, and at the horizontal junction of two scrobicular circles become much smaller, and the scrobicular circle more or less indistinct.

The median ambulacral zone is crowded with miliaries similar to those of the interambulacral zone, forming from eight to ten irregular vertical rows; the outer rows adjoining the poriferous zones consist of small secondary tubercles, carrying extremely elongate secondary spines of a grayish-green color, slightly darker at top of spine. The poriferous zone itself is proportionally narrower than in other species of the genus, compared to the great width of the ambulacral system.

Genital plates in contact laterally, of nearly uniform size; genital openings near centre of plates. Anal system small, covered by close granulation, formed of miliaries like those of the median ambulacral and interambulacral zones, and carrying similar papillæ. Ocular plates cordiform, separated from the genital plates by well-marked sutures between adjoining plates. The primary spines are more or less cylindrical, slightly tapering, with large spines along the whole length of the shaft, arranged in from six to eight irregular longitudinal rows, or with lamellæ forming ridges at the extremity of the spines, and extending towards base of spine, or with the shafts of the spines ornamented by irregular longitudinal rows of from six to eight small disconnected lamellæ; the color in alcohol is greenish, with dark olive-colored spines.

Sandwich Islands.

Phyllacanthus imperialis

! *Cidarites* **imperialis** LAM., 1816, An. s. Vert.

Phyllacanthus *imperialis* BR., 1835, Prod. Des. An.

Pl. I^e. f. 1–6; Pl. I^f. f. 6.

The primary spines of this species have a general resemblance to those of Heterocentrotus mammillatus. Though apparently smooth, they are covered by a uniformly packed close granulation, arranged in more or less close irregular longitudinal lines. Extremity of spines fluted; bare base of spine above milled ring not rigidly defined, striation of base passing gradually into granulation of the shaft. The spines are frequently ringed with two or three broad bands of yellow upon the dark violet ground of the shaft of the spine, which fades towards the base of the spines. In young specimens

these rings are narrow, close together, towards the extremity of the spine at the base of the fluting. The general color of the papillæ and secondary spines is dark violet.

Both in P. dubia and in P. imperialis there are but six large primary tubercles in the largest specimens I have had occasion to examine (test measuring 75$^{mm.}$ in diameter). The scrobicular circle of P. imperialis is well defined, circular, limited by one row of rather prominent secondaries. The mammary boss of primaries is prominent.

In the abactinal system the madreporic genital plate is considerably larger than the others; genital openings small, removed from outer edge of genital plates; granulation of abactinal system close; ocular plates crescent-shaped, with deep ocular pit equal in length to the width of the genital plates. Plates of anal system are small, with the exception of a row of large exterior ones opposite the madreporic genital plate, and gradually diminish towards the madreporic plate.

Median interambulacral space broad, covered by numerous irregular miliaries; the median ambulacral zone only slightly broader than the poriferous zone, with four to five irregular vertical rows of miliaries closely crowded together between the exterior rows.

Red Sea; East India Islands; Australia.

Phyllacanthus verticillata

! *Cidarites* **verticillata** LAMK., 1816, An. s. Vert.
! *Phyllacanthus verticillata* A. AG., 1872, Rev. Ech., Pt. I.

Pl. I^c. f. 40–42^a; Pl. I^f. f. 7.

This species, which is so well known from its peculiar spines, swollen at intervals along the shaft, has a test equally characteristic. The median interambulacral space is smooth, totally bare; the secondary tubercles are limited, in each coronal plate, to the single row forming the scrobicular circle, with but few irregularly scattered tubercles on each side of it, towards the outer edge of the plate. The primary tubercles are small, not prominent. The median ambulacral space, which is much broader than the poriferous zone, is also nearly smooth, with the exception of an extremely irregular vertical row of miliaries flanking the two vertical rows of miliaries, adjoining the outer secondary rows. This median space is slightly sunken, the outer rows of secondaries adjoining the poriferous zone becoming thus exceedingly prominent. The color of the secondary spines and papillæ is

greenish, tipped with a darker shade of the same color. The primary spines are of brownish tinge, with three to four greenish or yellowish-green rings; the granulation is coarse, arranged in longitudinal rows, frequently forming lamellæ at the base of the swellings along the shaft of the spines.

The abactinal system is but sparingly covered by papillæ; the genital openings are small; the ocular plates triangular; the anal system pentagonal; the genital plates, with one exception, where they are separated by ocular anal plates, are connected laterally.

Society Islands; Australia; East India Islands.

STEPHANOCIDARIS.

Stephanocidaris A. Ag., 1863, Bull. M. C. Z., I.

The peculiar structure of the abactinal system in this genus is thus far the only exception to the remarkable uniformity of structure of the solid abactinal system of all Cidaridae, in which the abactinal plates are generally solid, stout, immovable, and more or less covered with granules; in Goniocidaris we find in one of the species the outer edge of these plates free from tubercles, smooth. In this genus the whole abactinal system is thin, movable, resembling, in fact, far more the flexible anal system of Echinidae proper than the massive abactinal system of Cidaridae. The test is also exceedingly thin, but the remaining structural features of the test, spines, and buccal membrane do not differ essentially from those of the other Cidaridae. The number of primary tubercles is large; the poriferous zone as in Phyllacanthus.

Stephanocidaris bispinosa

! *Cidarites* **bispinosa** Lam., 1816, An. s. Vert.
! *Stephanocidaris bispinosa* Ag., 1872, Rev. Ech., Pt. I.

Pl. I^c. f. 43; Pl. I^f. f. 3.

Test thin, and further distinguished from all other Cidaridae by the structure of the abactinal system, made up of thin flexible plates. Abactinal system much larger than the actinal. Genital plates pentagonal, elongate; genital openings small, sometimes two for each plate. Ocular plates large, trapezoidal, completely separating the genital plates. Whole abactinal system moderately closely packed with miliaries.

Median ambulacral space broad, with five irregular vertical rows of mili-

aries between the outer rows of secondaries. Scrobicular circles ill defined, running into one another along the middle of the horizontal lines of contact. Broad median interambulacral zone. Secondary tubercles gradually diminishing in size towards centre of median space, filling edge of coronal plates between scrobicular circles and the poriferous zone. Secondary spines elongate, yellowish, with green stripe along the middle, tipped with pink. Ambulacral secondaries dark green. Primary spines flattened, tapering, with very marked serrated edges, and smaller spines along median line of shaft of spine; this is irregularly banded and spotted with violet, upon a greenish-yellow background. Color of collar of spine violet-brown, with white spots. Granulation of spines irregular, with longitudinal lines of larger granules, alternating or mixing in with smaller granulations. Plates of buccal membrane small, closely packed together. Primary tubercles small; mammary boss little prominent; auricles very high and thin.

Australia; East India Islands.

POROCIDARIS.

Porocidaris DES., 1854, Syn. Éch. foss., p. 46.

Among the most interesting genera collected by the Porcupine Expedition is a recent representative of this genus, hitherto only known from isolated coronal plates, and from spines fully bearing out the characters and peculiarities upon which this genus had been established. The coronal plates are pierced round the scrobicular circles by pores situated in shallow furrows radiating round the scrobicular circle; associated with these isolated fossil plates, we find peculiar spines, remarkable for their flattened form, longitudinally plicated, with strongly serrated edges. Milled ring prominent; collar distinct. In the recent specimens these flattened serrated spines were found to occur round the actinostome. The primary spines of the test above the actinostome are long, swollen at the base, tapering, and remarkable for the immense development of the collar, which extends frequently half the length of the shaft of the spine. Other spines are more cylindrical, all are finely granular, presenting a tolerably smooth surface. The collar is of a beautiful brilliant purple, according to Professor Thomson; and from this he has named the species mentioned below.

Porocidaris purpurata

! *Porocidaris* **purpurata** THOMS., 1869, Prel. Rept. Porcup. Exp.

Pl. I^c. f. 37–41; Pl. XXIV. f. 11.

Other peculiarities, such as the structure of the genital openings, will be shortly described by him in his final Report on the Echinoderms of the Cruise of the Porcupine, and I merely allude to this interesting species, of which the Museum owes him a specimen, to make this Revision as complete as possible, and leave for an Appendix a recapitulation of his description.

Rockall.

GONIOCIDARIS.

Goniocidaris DES., 1846, AGASS., C. R.

The test is frequently higher than broad; the coronal plates more numerous than in the other genera of Cidaridae. Tubercles perforate, with a smooth base. The ambulacra are narrower than in any other genus of the family; the poriferous zone is almost as broad as the median ambulacral region. The median ambulacral and interambulacral areas are bare; the sutures of the plates sunken, and forming, along the vertical sutures near the median line, and along the horizontal sutures, deep zigzag impressions, culminating in a pit at the angle of two plates. In each of these pits, both in the ambulacral and interambulacral zones, are situated large spherical pedicellariæ with a short stem, a single one frequently filling the whole pit in the interambulacral zone; they are not so abundant in the ambulacral zone. The spines are cylindrical, the surface covered with thorny spines, pointing irregularly outwards; flaring, and frequently cupped at the extremity.

Goniocidaris canaliculata

! *Temnocidaris* **canaliculata** A. AG., 1863, Bull. M. C. Z.

! *Goniocidaris canaliculata* A. AG., 1872, Rev. Ech., Pt. I.

Pl. I^c. f. 6–8; Pl. I^g. f. 2; Pl. XXIV. f. 10.

Abactinal system with slight cuts at angles of coronal plates; narrow furrow extending the whole length of the median ambulacral and interambulacral zones, following the sutures of the plates. Poriferous zone narrow, pores adjoining; ridge separating pairs of pores prominent. Scrobicular circle well marked, elliptical, surrounded by a prominent row of secondary tubercles, and near the median furrow by a second concentric row of smaller tubercles. Mammary boss small and distinct. Poriferous zone not equal in breadth to the

median ambulacral space. Besides an outer row of comparatively large secondary ambulacral tubercles, there are two irregular vertical rows on each side of the median furrow, with a few miliaries scattered irregularly between the secondary tubercles towards the poriferous zone.

Genital plates in contact, irregularly pentagonal; ocular plates lozenge-shaped; ocular pores near centre of plates; genital openings near edge. There are but few miliaries in the centre of each plate of the abactinal system. The primary spines are comparatively slender, short, slightly tapering, somewhat swelling at base, with indistinct fluting formed by lamellar granulation. Ambulacral papillæ somewhat rounded, longer and more slender than the scrobicular papillæ, which are considerably flatter. Covered with its spines and papillæ, this small species resembles strikingly in outward appearance Dorocidaris papillata, with shorter spines. The color of test and spines, to judge from drawings made by Captain Couthouy, at Orange Harbor, Falkland Islands, is of a brilliant orange, reminding us of the coloration of Dorocidaris papillata (C. affinis of Philippi) from the Mediterranean.

Patagonia; Natal.

Goniocidaris geranioides

! *Cidarites* **geranioides** LAMK., 1816, An. s. Vert.

! **Goniocidaris** *geranioides* AGASS., 1846, AGASS. Cat. Rais.

Pl. I^c. f. 15–17; Pl. I^g. f. 3, 4; Pl. XXIV. f. 12, 13; Pl. XXXV. f. 5.

Abactinal system uniformly covered by closely packed miliaries; sutures of the plates of abactinal system well defined. Ocular plates large, triangular; genital plates of uniform size, adjacent sides in contact; genital openings large, placed near edge of plates. Anal system small, pentagonal, covered by a moderate number of plates. Test high, thick; as many as ten primary tubercles. Scrobicular circle small, circular, well defined by a close row of secondary tubercles. Horizontal sutures of coronal plates left bare, bevelled towards the median interambulacral region; the angle of the plates terminating in a deep pit, the rest of the plate covered by closely packed secondary tubercles, diminishing gradually in size towards the median line. A narrow band of similar tubercles extends between the primary tubercles and the poriferous zone. The vertical line of median sutures is vaguely defined, left bare, but not deeply sunken. In young specimens the vertical lines of sutures alone are left bare, and the pits at angles of plates scarcely sunken. Mammary boss small, but projecting. Secondary spines rather short, of a brownish-red

color; papillæ quite short. Primary spines fluted, swelling near base, cupuliform at tip; near upper part of spine fluting often broken up into disconnected lamellæ, or forming rugose projections, apparently irregularly scattered.

Median ambulacral space broad, sloping towards median line; each plate covered in central part with closely packed miliaries, forming five to six irregular vertical rows of horizontal and vertical sutures, deeply furrowed, ridges thus formed meeting almost on the median line. Poriferous zones narrow, with high ridge separating the pairs of pores.

East India; Australia.

Goniocidaris tubaria

! *Cidarites* **tubaria** LAMK., 1816, An. s. Vert.
! *Goniocidaris tubaria* A. AG., 1872, Rev. Ech., Pt. I. p. 131.

Pl. I^e. f. 32–36; Pl. I^c. f. 9–14.

Test somewhat flattened, eight primary tubercles; vertical and horizontal furrows of median line of coronal plates forming a continuous groove from abactinal system to buccal membrane. Scrobicular circle elliptical; mammary boss small, not prominent. Three to four rows of small miliaries, concentric with the row of secondary scrobicular tubercles, upon each interambulacral plate, with a narrow band of similar miliaries separating primary tubercles from the poriferous zone.

Primary spines somewhat swelling at base, tapering, cupuliform; shaft of spines ornamented by irregular longitudinal rows of small, flattened, disconnected, pointed lamellæ, forming diminutive spines. Color of spines is greenish-yellow, with numerous pink patches of color scattered irregularly over the shaft of the spine. Spines frequently smooth, regularly striated longitudinally, by extremely fine granulation, with irregular spots of dark violet scattered upon a pinkish-yellow ground-color. Secondary spines and papillæ yellowish at base, tipped with brown. Plates forming abactinal system covered with miliaries near centre only, leaving broad bare sutures between all the plates. Genital openings small, placed near centre of the genital plates, in very centre of main patch of miliaries covering it.

This species differs strikingly from G. geranioides in the structure of the primary spines; the differences in the size of the genital plates and abactinal system giving excellent characters by which these two species are easily distinguished.

The resemblance of the primary spines and of the abactinal system of this species to Stephanocidaris bispinosa is quite striking, and unless the specimens are denuded it is easy to mistake the two species when covered with spines and papillæ; hence the confusion which has existed regarding Cidarites bispinosa, tubaria, and Goniocidaris Quoyi, owing to the general outward resemblance of the primary spines of Goniocidaris and of Stephanocidaris.

The median ambulacral zone is bare; the whole median ambulacral space is sunken, and lined on both sides with irregular miliaries, adjoining the two principal rows of secondaries next to the poriferous zone. The poriferous zone is broader in proportion than that of G. geranioides.

Australia; Tasmania.

SALENIDAE.

Subfamily **Salenidae** AGASS., 1838, Mon. Éch. Salénies. (emend.)

Small Echini with narrow ambulacral zones. Interambulacral tubercles forming ten primary vertical rows. Abactinal system remarkable for the soldering together of the anal and genital plates, the deep sutural cuts and pits formed upon the plates of the abactinal system; structure of the spines similar to that of Cidaridae.

For further details see p. 258 of Part II., the description of the only living Salenia thus far found.

SALENIA.

Salenia GRAY, 1825, Ann. Phil.
(See Part II. p. 258.)

Salenia varispina

! **Salenocidaris varispina** A. AG., 1869, Bull. M. C. Z., I.
! *Salenia varispina* A. AGASS., 1872, Rev. Ech., Pt. I. p. 155.
(See Part II. p. 261.)

Pl. III. f. 8–14; Pl. XXXV. f. 16.

Straits of Florida.

ARBACIADAE.

Family **Arbaciadae** Gray, 1855, Proc. Zoöl. Soc. London.

The Echini composing this family are few in number; but the characteristic features are so striking, as intermediate between the Goniocidaridae and the Diadematidae and Echinidae proper, that it was impossible to include them in either of the above families. The absence of the characteristic secondary, miliary, and granular tubercles of the Echinidae, the limitation to the number of vertical rows of primary tubercles, much as in Diadematidae; the peculiar structure of the actinostome, — are features which separate this small group from either of the families mentioned. The structure of the jaws is peculiar: they are elongate, as in Cidaris, with a small foramen; the arch of upper extremity of jaw is open, as in Cidaridae and Diadematidae. The teeth are shaped as in the Diadematidae and Echinidae proper. The auricles are disconnected. The poriferous zone is simple; pores not arranged in horizontal rows, somewhat as in Goniocidaridae. The abactinal system is, in all genera thus far found to belong to this family, peculiarly ornamented. The anal system consists of only four large triangular plates. The structure of the spines is intermediate between that of the Goniocidaridae and Echinidae. The centre of the spine, as well as the exterior, is made up of small limestone cells, as in Cidaris, closely packed, irregularly arranged, with the exception of a ring at some distance from centre, made up of large, open limestone cells, as in Echinidae. The outer sheath of the spines of the Arbaciadae is limited to the extremity of the spines, forming a sort of cap. This has been well described by Desmoulins.

ARBACIA.

Arbacia Gray, 1835, Proc. Zoöl. Soc. London.
(See Part II. p. 263.)

Arbacia Dufresnii

! *Echinus* **Dufresnii** Bl., 1825, Dict. Sc. Nat. O.
! **Arbacia** *Dufresnii* Gray, 1835, Proc. Zoöl. Soc. London.

The dry denuded tests of this species, frequently occurring in collections, are at once distinguished from any other species of the genus by the brilliant green bare band in median interambulacral space, extending nearly to the ambitus. This bare band is flanked by only one row of large primary tubercles, distant, occurring frequently only on every other coronal plate; the intermediate tubercles being small, only two; the inner row composed

of small tubercles. These vertical primary interambulacral rows are placed close to the poriferous zone; the space between the primary tubercles is completely filled by miliaries, carrying very minute pedicellariæ. The granulation of the bare median band is fine. The lines of growth of the edge of the plates are well marked, forming colored zigzag lines, parallel to the median interambulacral sutures. Immediately above the ambitus, and over the whole actinal surface of the test, the primary tubercles of the interambulacral spaces are closely packed, arranged in three vertical rows on each side of the median line, forming at same time diagonal rows parallel to the sutures of the plates of the interambulacral system. The tubercles are largest near ambitus, diminishing gradually in size towards the actinostome. The median ambulacral space has but two irregular vertical rows of small tubercles of uniform size, increasing suddenly in size at ambitus, and diminishing towards the actinostome. The lips of the actinal cuts are scarcely marked; coronal plates narrow and numerous; actinostome proportionally small; abactinal system large, resembling in general arrangement that of A. punctulata; the genital plates are more rectangular, covered by a closer granulation; the ocular plates excluded from the anal system, large, heart-shaped, extending to limit of the genital plates; genital openings large, close to apex of genital plates; granulation of ocular plates forming indistinct radiating lines from ocular opening. The ten buccal plates of actinal membrane large; otherwise no specific features in the structure of the buccal membrane. The spines are comparatively long, and correspond closely to the general appearance of the spines of A. punctulata. In alcohol they are dull violet in color.

There has always been considerable doubt of the localities of this species. The originals of Blainville were supposed to come from the Banks of Newfoundland; it has been mentioned as coming from the Sandwich Islands, and the West Coast of Africa was also supposed to be its true locality. Dr. Cunningham has collected quite a number of specimens, now deposited in the British Museum, in the Straits of Magellan; there are also specimens from Chili in the École des Mines. So that, whatever may be the ultimate range of this species, it is, like the other species of the genus, essentially American.

Philippi has described this species from Chili, under the name of E. Schythei.

No. Interamb. Plates.	Diameter.	Height.	Diameter Abact. Syst.	Diameter Anal Syst.	Diameter Actinal Syst.
17.	40.	23.	11.5	6.	21.
15.	35.2	18.	9.8	5.1	18.
11.	21.4	10.2			12.

Patagonia; Chili.

Arbacia nigra

Echinus niger (**Molin.**), 1782, Chili.

! **Arbacia** *nigra* GRAY, 1835, Proc. Zoöl. Soc. London.

Pl. I^e. f. 6, 7.

Abactinal system remarkable for the great size of the anal system, surrounded by small, triangular genital plates, three of which are separated by the ocular plates, reaching to the anal system. The genital plate carrying madreporic body is much larger than the others, though with younger specimens this difference in size is not so marked; genital openings large; ocular plates small, often mere knobs in older specimens; granulation of abactinal system forming radiating lines over the anal and the genital plates. Interambulacral coronal plates much higher nearer abactinal system than towards ambitus. Above ambitus coronal plates carry one large tubercle, close to the poriferous zone, from which extends a horizontal row, parallel with the suture of plates of as many as four smaller tubercles, diminishing, according to their position, towards the median line, placed near the lower part of the plate. The upper part of the plate is filled with secondary tubercles of nearly uniform size, irregularly arranged, the whole space between them filled by miliaries carrying pedicellariæ. The secondary tubercles are frequently united, leaving the interambulacral median space above ambitus more or less bare, covered simply by granulation of miliaries. The narrow coronal plates from ambitus to actinostome carry one row of large primary tubercles of uniform size, closely packed together, forming diagonal transverse rows, and, in connection with the horizontal rows of the upper part of test, more or less apparent vertical rows. The horizontal rows of the primary tubercles of the actinal part of test are separated by miliaries. There are two well-defined vertical rows of primary tubercles, of nearly uniform size, in the median ambulacral space, surrounded by a ring of miliaries. These are flanked by a broad poriferous zone, the pores being crowded laterally at an early age ($35^{mm.}$, diam.), so that, in large specimens, the pores appear arranged in an irregular, zigzag manner. Owing to this lateral crowding of the pores, the poriferous zone is extremely petaloid round the actinostome, the interambulacral space being reduced to a very narrow point between the prolongation of the prominent lip of the actinal cuts.

Test regularly arched; outline more or less circular; the test frequently more or less gibbous, especially near ambitus in the interambulacral zone. The spines of the upper part of test, in median interambulacral space, are quite

short, flanked externally by a line of longer spines next to poriferous zone. Immediately round ambitus the spines are longer; the general coloring of spines and test is dark violet. Dried tests are usually light violet or brownish-yellow, with purple patches in median interambulacral space. This sea-urchin appears to be the most common species of the western coast of South America. As I have shown in A. punctulata, it is not natural to separate A. nigra and A. pustulosa from the other species of the genus, on account of the greater number of the primary tubercles; the only other difference in A. nigra which would be considered generic — the position of the ocular plates — is not alone sufficient to withdraw it from the present association.

No. Interamb. Coron. Plates.	Height.	Diameter	Diameter Abact. Syst.	Diameter Anal Syst.	Diameter Actinal Syst.	Length of Spines.
20.	39.3	75.	13.	8.	29.	
18.	26.8	68.2	12.9	7.8	29.	
18.	33.4	62.4	12.5	7.6	29.	
17.	26.	56.	12.6	7.	24.8	[17. diff. spn.]
16.	29.	49.1	10.	5.8	24.	[23. diff. spn.]
15.	21.5	43.2	9.	5.1	20.	
14.	15.2	35.8	7.8	4.	17.	
12.	12.	25.			13.	

Patagonia; Peru.

Arbacia punctulata

! *Echinus* **punctulatus** LAM., 1816, An. s. Vert.

! **Arbacia** *punctulata* GRAY, 1835, Proc. Zool. Soc. London.

(See Part II. p. 263.)

Pl. II. f. 4; Pl. V. f. 1–18; Pl. VI. f. 22; Pl. XXVI. f. 3–7; Pl. XXXV. f. 8; Pl. XXXVIII. f. 10.

Long Island Sound; West Florida.

Arbacia pustulosa

! *Cidaris* **pustulosa** LESKE, 1778, KLEIN, Add.

! **Arbacia** *pustulosa* GRAY, 1835, Proc. Zoöl. Soc. London.

Pl. I^g. f. 5; Pl. II^a. f. 15–33; Pl. V. f. 19–21; Pl. XXVIII. f. 6; Pl. [XXXVIII. f. 10^{a–c}.

This species is remarkable for the narrow ring of genital plates forming the abactinal system; the elongate anal system; the narrow coronal plates, completely crowded by closely packed tubercles, arranged parallel to the sutures, of uniform size, with as many as seven to eight tubercles in each horizontal row on the sides of the median line. There is no tendency in the tubercles to a vertical arrangement in older specimens, they simply form irregular vertical lines; while in younger specimens the vertical arrangement is moderately apparent. The spines are more slender and shorter than in A. punctulata. The actinostome is also proportionally larger than in the American

species. The original specimens of Lamarck, though slightly worn, are identical with the Brazilian variety of A. pustulosa, which I formerly attempted to distinguish from A. aequituberculata, the common Mediterranean species. Specimens of this species are said by Desmoulins to have been introduced in La Rochelle on the bottom of vessels; they are most similar to the Liberian specimens, the spines of which are frequently tipped with yellow.

No. Interamb. Coron. Plates.	No. Prim. Tub. Interamb. V. Rows.	Diam. Abact. System.	Diam. Act. System.	Diameter.	Height.	Length of Spines.
20.	12.	12.	28.	57.	32.	26.
18.	11.	10.5	26.5	52.4	22.5	
17.	10.	10.	23.2	47.	22.	22.
17.	8.	7.4	17.	33.	15.	
13.	7.	6.	12.8	22.9	9.9	

Mediterranean; Liberia; Brazil.

Arbacia spatuligera

! *Echinus* spatuliger VAL., 1846, Voyage Vénus.

! *Arbacia spatuligera* A. AG., 1872, Rev. Ech., Pt. I. p. 93. [*Pl. XXXV. f. 7.*

This species is intermediate between A. nigra and A. pustulosa. It has, like A. pustulosa, narrow interambulacral coronal plates, and but one horizontal row of primary tubercles on each plate; the rest of plate is covered by uniform miliaries, except a small part of the younger plates near the abactinal system, which is left bare, as in A. stellata, A. punctulata, but, of course, much smaller; it has, like A. nigra, the primary tubercles placed near the lower suture of the coronal plates. The genital plates are not of equal size; they diminish rapidly in size as they are placed nearer or farther from the madreporic body. The ocular plates are in contact with the anal system, but the genital ring is not as narrow as in either its nearest allied species, resembling more the genital system of A. punctulata: in younger specimens frequently only one ocular plate reaches the anal system, opposite the genital plate carrying madreporic body, the other gradually approaching it, with increasing size.

There is a marked difference in the size of the primary tubercles above and below the ambitus. The tubercles of the actinal part of the test are largest near the ambitus, decreasing rapidly in size towards the abactinal pole, and slowly towards the actinostome, forming on the actinal part of the test as many as eight to ten irregular vertical rows, decreasing in number towards the abactinal pole, leaving the small, bare, abactinal median part of the interambulacral space flanked by three to four vertical rows of small primary tubercles, with a larger vertical row adjoining the poriferous zone. On the

actinal part of the test there are four diagonal rows of nearly uniform-sized tubercles. The ambulacral and interambulacral tubercles are of nearly the same size on that part of the test, but the former decrease rapidly in size above the ambitus, corresponding fully to the decrease of the primary interambulacral tubercles. The actinal cuts are broad, deeply cut, with prominent lips.

The abactinal part of the poriferous zone above the ambitus is very broad, although the pores are not crowded laterally as in A. nigra. The nature of the spines is very variable in this genus, and the spathiform character of the spines of the lower surface was only found to exist to an unusual extent above the ambitus in the original specimens of Valenciennes. The actinostome is comparatively small, as in A. nigra. The auricles of the specimens examined are barely connected.

Dried specimens are light brown, with reddish tinge below, of a dark ground-color of same shade in median interambulacral zone above ambitus.

Test with a rounded outline uniformly arched, but less pentagonal than A. pustulosa, though not often conical as in A. punctulata, and less depressed than A. stellata.

No. of Coronal Interamb. Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.
19.	67.	34.9	13.	7.	30.
	58.				28.8
17.	54.	25.	11.	6.8	25.

Chili; Peru.

Arbacia stellata

! *Echinus stellatus* (**Blainv.**), 1825. Dict. Sc. Nat. O.
! **Arbacia** *stellata* GRAY, 1835. Proc. Zool. Soc. London.

The facies of this species recalls strongly Arbacia punctulata, to which it is extremely closely allied; the proportion of the spines to the test, their mode of distribution, and the general structure of the abactinal system, is nearly the same. It differs from it in the greater breadth of the ambulacral zone, due to the greater width of the poriferous zone; the ambulacral zone rising above the level of test, giving to the outline a more or less pentagonal aspect. The height of the coronal plates is greater, the size of the primary tubercles larger; and in specimens thus far collected the bare median interambulacral space remains quite marked, but not as distinctly prominent as in A. Dufresnii, the primary vertical rows of tubercles not extending much above the ambitus. At the ambitus the ambulacral and interambulacral tubercles are nearly of the same size. The part of the plate occupied by the miliary granu-

lation surrounding the primary spines is limited much as in A. Dufresnii, and in spite of the striking differences thus far noticed in these two species, it may be that A. stellata and A. Dufresnii may turn out one species. From inability to decide, for want of material, which of these two species of Arbacia Blainville intended to denote by this name of stellata, as it is eminently applicable to both, the young specimens of this species were described by myself, and afterwards by Dr. Lütken, under a new name. An examination of the originals leaves no doubt as to which of the two species Blainville intended to apply the name.

The large, prominent abactinal system, with its pointed genital plates, projects into the bare median interambulacral spaces; a marked star-shaped pattern is seen from above, owing to the peculiar pattern of coloration of the genital plates of the median sutural interambulacral line. Actinal cuts extremely shallow; lips of cuts long, but not marked.

The prominence of the interambulacral sutural lines of young specimens is quite marked. The genital plates on the edge surrounding the anal system are covered by miliaries, differing in this respect strikingly from all specimens of A. Dufresnii, in which the ornamentation of the genital and anal plates is totally different; the median abactinal part of the bare interambulacral space is often somewhat depressed. The color of the test of dried specimens is grayish, with a purple tinge, or frequently light pink, with angular markings along the median interambulacral line, on the lower part of the coronal plates, extending from the apical system to the ambitus. Alive the color is dark violet, with a somewhat lighter background to the bare median interambulacral space.

No. Coronal Interamb. Plates.	Height.	Diameter.	Anal System.	Abactinal System.	Actinal System.	Length of Spine.
16.	25.4	49.	6.	14.	22.	39.
13.	19.8	42.1	6.1	13.2	20.5	
11.	13.	25.	4.	7.5	15.	
10.	11.	18.	3.	6.	11.3	17.

Panama; Gulf of California.

PODOCIDARIS.

Podocidaris A. Ag., 1869, Bull. M. C. Z., I.
(See Part II. p. 269.)

Podocidaris sculpta

!**Podocidaris sculpta** A. Ag., 1869, Bull. M. C. Z., I.
(See Part II. p. 269.)

Pl. IV. f. 8–16.

Straits of Florida.

COELOPLEURUS.

Coelopleurus Agass., 1840, Cat. Ectyp.
(See Part II. p. 267.)

Coelopleurus floridanus

! *Coelopleurus* **sp.** A. Ag., 1871, Bull. M. C. Z., II.
! *Coelopleurus* **floridanus** A. Ag., 1872, Rev. Ech., Pt. I. p. 102.
(See Part II. p. 267.)

Pl. II^c. f. 14–15.

Straits of Florida.

Coelopleurus Maillardi

! **Keraiaphorus Maillardi** Mich. 1862, Maill. Bourbon Ann. A.
! *Coelopleurus Maillardi* A. Ag., 1871, Bull. M. C. Z. II. p. 456.

Test somewhat compressed. Ambulacral zones broad, covered with two principal vertical rows of tubercles, becoming larger towards ambitus; on the actinal side of test, of uniform size with the interambulacral primary tubercles; the tubercles of both zones remarkably uniform in size. Median ambulacral zone above ambitus carrying few secondary tubercles, forming an irregular vertical median row; the median line of ambulacral space is pitted with sutural impressions between the actinostome and ambitus. There are but two principal vertical rows of primary interambulacral tubercles, extending only a short distance above ambitus; the abactinal part of the median interambulacral space is covered by miliaries of uniform size, arranged in ridges, running in S-shaped curves from the base of one plate to the angle of the opposite plate, across the bare part of the zone. This bare part is further circumscribed by a broad band of secondary tubercles and larger miliaries, extending on each side of the interambulacral zone, next to the poriferous zone, between it and the principal vertical rows of tubercles, from the abactinal system to the actinal surface. Poriferous zone is narrow; pores, arranged in vertical arcs of three round base of primary tubercles, do not become petaloid round actinostome. Primary tubercles neither perforate nor crenulate; no well-defined scrobicular circle. Actinostome of moderate size, with slight cuts, the narrow, sharp lips of cuts well defined. Abactinal system has a nearly circular anal system, surrounded by a row of large miliaries on the edge of the genital plates, which are of uniform size with genital openings situated in centre of plate; madreporic genital slightly largest. Ocular plates broadly triangular; ornamentation of abactinal plates formed

by radiating ridges, round outer edge of genital plates and inner point of ocular plates; in the only specimen existing, brought up on a fishing-line from a depth of 200 metres, the anal plates as well as the buccal membrane were wanting. The spines of the primary tubercles are immense, totally unlike the spines of any other Echini, three times as long as diameter of test; they are curved, triangular at base, with one rounded side, tapering very gradually; the milled ring is oblique; articulating boss smaller than shaft of spine; they are pinkish at base; body of shaft greenish, with purple bands. The spines surrounding actinostome are short, straight, flattened, only banded on one side, resembling spines of Arbacia. The miliary spines are narrow, cylindrical, longitudinally striated by minute serrations, usually of a brilliant purple; jaws resembling those of Arbacia.

Bourbon.

DIADEMATIDAE.

Family **Diadematidae** PETERS, 1853, Monatsb. Akad. Berl. (emend.)

The test is thin, the ambulacra narrow; ambulacral suckers pointed near upper abactinal pole; interambulacra depressed near abactinal system. Spines long, hollow, verticillate; tubercles of both areas similar in structure; actinal cuts moderately developed, and in one genus ambulacra extending to the mouth, as in the Cidaridae. The jaws and apophyses send out thin processes, not forming connected arcs; teeth channelled as in Cidaridae.

The arrangement of the pores of Diadematidae when young is identical with the arrangement of the pores found in such genera as Pseudodiadema, Cyphosoma, Hemipedina, in which we are unable to say whether they belong to the Oligoporidae or Polyporidae, forming, as they do sometimes, arcs of three or four pairs of pores round the base of the primary tubercles; showing in young specimens, measuring $12^{mm.}$ already, but a faint trace near actinostome of the arrangement of the pores in arcs of three. The abactinal system is also remarkably different in structure from that of the adult, the genital plates resembling more the pentagonal plates of the genital system of Centrostephanus, and becoming pointed only with advancing age; the base of the anal membrane adjoining the ring of genital plates is strengthened by a row of small plates, which disappear in the older specimens or are resorbed in the anal membrane.

DIADEMA.

Diadema SCHYNV., 1711, Thes. Imag. (Pet. emend.)
(See Part II. p. 274.)

Diadema mexicanum
! *Diadema* **mexicanum** A. AG., 1863, Bull. M. C. Z., I.

Pl. XXXVIII. f. 3–6.

As I have already mentioned in Part II. of this Revision, I am unable to discriminate more than two species of Diadema. Even the differences of these two species are not great, amounting only to a difference in the proportions of the actinostome and the test, of which comparative measurements have been given on page 275. The variations in the thickness and length of the spines is so great that it is impossible to draw any permanent characters from them; yet, as a whole, the spines of D. mexicanum are stouter, though longer, as compared with diameter of test, than those of D. setosum, which vary immensely, according to size and locality. The spines are usually banded in young specimens of both species. Abactinal system is larger in proportion than in D. setosum, with a larger anal system and larger genital plates; poriferous zone somewhat broader, and the outer row of interambulacral tubercles, adjoining poriferous zone, of uniform size, diminishing but little towards abactinal pole, and nearly reaching the ovarian plates without material decrease in size. Actinal cuts not deep, but broad; while usually they are much narrower in specimens of D. setosum of the same size. The verticillations of spines are finer in D. setosum than in D. mexicanum. Although a large number of specimens of all sizes of these two species have been examined and compared, I am unable to give any more satisfactory discrimination between them; the pedicellariae do not help us in the comparison.

Acapulco; Cape St. Lucas.

Diadema setosum
! *Diadema setosa* (**Gray**), 1825, Ann. Phil. (non RUMPH.).
(See Part II. p. 274.)

Pl. II^b. f. 6–10; Pl. II^c. f. 6; Pl. IV^a. f. 1; Pl. VI. f. 15; Pl. VI^a. f. 5; Pl. XXIV. f. 38–39; Pl. XXVII. f. 5; Pl. XXVIII. f. 5.

West India Islands; Cape Verde Islands; Indian Ocean; Japan; Sandwich Islands; Feejee Islands.

(DIADEMA.) CENTROSTEPHANUS.

Centrostephanus PET., 1855, Denksch. Akad. Berlin.

Peters proposed to separate Diadema longispina of Philippi from the other Diadematidae, on account of the globular outline of the test, and the presence of ten large buccal plates; subsequently I distinguished the genus Thrichodiadema from the absence of a bare forking interambulacral space and the peculiar structure of the abactinal system. This is nearly circular, the genital plates being pentagonal, and the anal system covered by comparatively numerous, distinct plates unlike Diadema; and still later, Verrill established the genus Echinodiadema upon nearly the same grounds as Peters. An examination of original specimens satisfies me that the genus Centrostephanus includes the genera of both Verrill and myself. The tubercles of both areas are similar (as in Diadema and Astropyga), and arranged in two vertical rows in the ambulacral zone. The buccal membrane is strengthened by ten large plates, carrying spines as well as pedicellariæ, — a feature not known in any other genus of this family. The ocular plates are pushed out from the genital plates by one small plate of the anal system, which separates the genital plates. The stout spines resemble more the larger ones of Echinothrix, with closer verticillations, than those of Diadema; they are still more hollow, mere shells; actinal openings slight. The pores are arranged in arcs of three, somewhat as in Astropyga and Diadema. Shell thick; tubercles crenulated and perforated. Teeth do not differ from those of the Diadematidae generally.

Centrostephanus coronatus

! **Echinodiadema coronata** VERRILL, 1867, Notes Radiata.
! *Centrostephanus coronatus* A. AG., 1872, Rev. Ech, Pt. I.

Owing to great difference in size of C. coronata and C. Rodgersii, no comparison can be made of the rows of tubercles in the interambulacral spaces in the two species. The actinal opening seems rather larger in proportion (C. coronata), even after allowance for difference of size. The abactinal region is also less depressed: but what will at once characterize this species are, the striking differences noticed in the abactinal system; the greater size in C. coronata of the genital plates in proportion to the ocular plates, their (genital) more elongate and pentagonal form, as well as a similar

difference in the ocular plates, which are far broader and more elongated laterally in C. Rodgersii than in C. coronata, where the ocular plates are nearly hexagonal. Another very important difference is shown by the spines, which, as far as I have observed, in Echinothrix, in Astropyga, and in this genus, offer good specific differences. We will leave out of question their greater proportional length in C. coronata, on account of the difference in size, and simply compare the verticillations: we find in C. coronata the whirls very large and very distinct, the height of two whirls being equal to the diameter of the spines, while in C. Rodgersii five whirls are equal to the diameter of the spines; the whirls are also much less regularly arranged, the spines often appearing striated longitudinally in consequence; the verticillation being very slightly prominent. A similar structure exists in older spines of C. coronata; there are sixteen longitudinal lines in C. coronata, only eleven in C. Rodgersii. Actinal cuts more marked in Rodgersii; but this is a feature which, having developed with increasing size, can scarcely be taken into account.

The following is the description of a small specimen of this species as given by Professor Verrill, in his Notes on Radiata, page 295.

"Test circular, much depressed; actinal opening one half the diameter of test, with very slight cuts, its membrane partially covered by five principal groups of large oblong scales, which support numerous slender, somewhat clavate spines, .1 inch long, and numerous short, rounded pedicellariæ. Ambulacral pores large, in arcs of three pairs, becoming more oblique below, where the zones are wider; tubercles in two rows, rather large, with a median zigzag line of miliaries. Interambulacra about twice as wide as the ambulacra, with two rows of tubercles, somewhat larger than those of the ambulacra, reaching the abactinal region; external to these are two irregular rows of small tubercles bordering the ambulacra; and between them two imperfect rows of about the same size, arranged alternately, with smaller miliaries scattered among them. The three uppermost tubercles of both the ambulacral and interambulacral system are very small, and the two next the last bear small slender spines with globular, bright purple tips. The ocular and genital plates bear each a somewhat longer, slender spine. Abactinal system small, somewhat angular, depressed; spines twice as long as the diameter of the test, rather stout, with conspicuous verticillations, annulated with narrow bands of purplish-brown and light brown.

Diameter of test 0.85 of an inch; height, 0.35.

Cape St. Lucas.

Centrostephanus longispinus

Cidaris (*Diadema*) **longispina** PHIL., 1845, Wieg. Arch.

! **Centrostephanus** *longispinus* PET., 1855, Seeig. v. Moss., p. 109.

The only specimens of this species I have been able to examine were covered with spines, and in this condition the following features may be added to the description of Philippi. The genital plates are somewhat pointed, separated by one or two anal plates; the ocular plates are small, more or less rectangular. The upper part of the test is bare, both in the ambulacral and interambulacral spaces.

The pores are arranged in nearly vertical rows, forming arcs of three pairs only near perisome; actinal cuts very slight.

Aradas, who is the only one who, since Philippi and Agassiz, has described a specimen of Diadema from the Mediterranean, does not give us any additional information concerning this species; this is the more requisite, as the West Indian Diadema setosum occurs at Madeira and also in the Mediterranean. From the external examination it was possible to make of the originals of Agassiz and Philippi, sufficient could be seen of the abactinal system to show its peculiar structure, and also of the buccal membrane, showing the ten large buccal plates carrying small spines so characteristic of Centrostephanus. It is very important that the denuded test should be examined; the only clew we have of its distinguishing features being the few words of Philippi, in his original description: "C. testa pallide isabellina, orbiculari, utrinque valde depressa, ambulacris serie duplici tuberculorum munitis; areis interambulacralibus serie duplici tuberculorum majorum, serieque tuberculorum mediae magnitudinis utrinque inter tubercula majora et ambulacra munitis; aculeis longissimis, (diametrum testae sesquies aequantibus) violaceo et albido articulatis, longitudinaliter striatis et verticillato-aculeatis, verticillis fere aeque altis ac latis; assulis supremis aculeis majoribus destitutis. Diam. 27‴; Alt. 13‴; Long. max. acuberum 42‴; diam. $\frac{1}{2}$‴."

Philippi mentions the presence of short club-shaped spines, of a bright vermilion color, on the upper part of the test, on the plates adjoining the abactinal system. These small club-shaped spines are found on all species of the genus, on the newly formed coronal plates, of which there are sometimes three to five small plates, formed in rapid succession in the flat part of the abactinal part of test; in younger specimens these plates remaining of a small size, carry but one minute tubercle, smaller than the smallest

secondaries, and suddenly increase rapidly in size, when they carry long spines like all the rest of the coronal plates.

Palermo; Canary Islands.

Centrostephanus Rodgersii

!**Thrichodiadema Rodgersii** A. Ag., 1863, Proc. Acad. N. S. Phila., p. 354.

! *Centrostephanus Rodgersii* A. Ag., 1872, Rev. Ech., Pt. I. p. 98.

Pl. III^b. f. 1–3; Pl. XXIV. f. 37.

The two primary rows of tubercles of the ambulacral zone are closely crowded together, owing to their size, which is nearly as large as the principal primary tubercles of the interambulacral area. The median ambulacral line is occupied by a zigzag vertical line of miliaries. The poriferous zone is narrow; pores large, distinct. In the interambulacral space there are two principal vertical rows of tubercles larger than the others, flanked by two shorter vertical rows towards poriferous zone, and one vertical row on each side of the median line; all these tubercles are somewhat smaller than those of the primary rows of the ambulacral zone, and considerably smaller than those of the two principal interambulacral rows. The miliaries are moderately closely packed between the rows of smaller tubercles. The actinal system is large, with but slight actinal cuts. Verticillations of spines close; they are so arranged that spines appear irregularly longitudinally striated. Outline of test circular from above, seen in profile regularly arched; abactinal part of test flattened, turban-shaped. Auricles slight, with a low connecting ridge and large auricular arch. Madreporic genital exceeding greatly in size the other genital plates. Genital plates pentagonal, three separated by a rectangular anal plate, the other two, adjoining madreporic genital plate, by a smaller triangular plate; genital opening large, placed near outer edge, irregularly covered by small tubercles. Three of the ocular plates are irregularly hexagonal, with outer edge rounded; the three shortest sides forming the broadest outer edge of the plate; the other two adjoining madreporic genital are triangular. Small elliptical plates cover the whole anal system; a few only, somewhat larger, having a small tubercle, carrying minute spines. Buccal membrane, in addition to the ten large buccal plates, carrying small secondary spines, strengthened by longitudinal plates, in continuation of ambulacral system.

According to Dr. Stimpson, the color is deep reddish-purple when alive.

Australia; New Caledonia.

ECHINOTHRIX.

Echinothrix Peters, 1853, Monatsb. Akad. Berlin.

Peters first called attention to the differences of the ambulacral system existing in several species of Diadematidae referred by Agassiz to Astropyga. Gray and Desor subsequently established the genera Garelia and Savignya to include the same type. This genus combines the features of Diadema and of Astropyga. It has more the general facies of Diadema, a high test, moderately stout; larger tubercles and fewer vertical rows than Astropyga in the interambulacra; the ambulacra, however, differing very materially in having many vertical rows of very small tubercles in place of the larger tubercles of uniform size which characterize both Astropyga and Diadema. Their structure is the same with that of the large ones, however. The ambulacra also are much broader near the abactinal system, becoming petaloid there; the space between the two primary rows of small tubercles is filled with tubercles of nearly the same size, forming irregular vertical rows, the median ambulacral zone becoming very much broader than the poriferous zone; the reverse is the case on the actinal surface, where the poriferous zone is broader than the median ambulacral space. The poriferous zone is broad, and the pores are arranged as in Astropyga. At first glance the spines of the two areas appear very different; they are only of different size, the structure is nearly identical, — the one being very fine elongated silk-line spines, the other large verticillate or longitudinally striated spines, not as hollow as in Diadema, but having more the solidity of those of Astropyga. The anal system is strongly protected at the base by plates, as in Astropyga. The abactinal system resembling that of Astropyga, but plates not quite so elongate. There is no bare forked median interambulacral space, as in Astropyga.

Echinothrix calamaris

Echinus **calamaris** Pall., 1774, Spic. Zool.
! *Echinothrix calamaris* A. Agass., 1872, Rev. Ech., Pt. I. p. 120.

Pl. III^a. f. 1–2; Pl. XXXV. f. 10–15.

This species is more closely related to E. Desorii, and is subject to considerable variations in the proportions and size of the spines. Unlike the young of E. turcarum, the spines of the young of this species are comparatively shorter, but at the same time also proportionally much broader, more or

less spreading at extremity, hollow for their whole length, and extremely thin and delicate. The spines of older specimens frequently retain these characteristics of the young until they attain quite a large size; generally, however, with increasing age and size the spines become comparatively more tapering and stouter. The test is intermediate between that of E. turcarum and E. Desorii, having larger and more prominent tubercles than the latter, but still with narrower coronal plates than the former. In the interambulacral region the bare median space extends nearly to the ambitus. There are but four primary tubercles to each coronal plate, few secondaries, and the miliaries are more prominent and more numerous than in either of the other two species. The scrobicular circle of the primaries is marked and well defined, the primaries of the actinal surface gradually diminishing towards the actinostome, which is proportionally larger than in the other species of the genus. The actinal membrane is in the prolongation of the ambulacra, closely covered by large limestone plates. The ambulacra are broad, the poriferous zone of median breadth, from three to four median rows of secondary tubercles between the two outer ones. Ambulacra near the abactinal system slightly raised, so that the test of both this species and E. Desorii is slightly gibbous near ambitus, with flattened actinal surface and somewhat conical outline towards the abactinal pole, with depressed abactinal area. The abactinal system is remarkable for the great size of the anal system, covered by a thin membrane only strengthened by a few limestone granules, a single row of plates near the genital ring, and the small size of the equilaterally triangular genital plates separated by greatly elongated ocular plates. The color of the spines varies from a uniform straw color to light violet-colored spines, with four or five broad bands of a darker color; the test and ambulacral spines being generally of darker tint. Crenulation of the tubercles is quite indistinct, and in young specimens can scarcely be traced. The actinal membrane of the young is thickly covered by plates, as well as the anal membrane; the outline of small specimens is also more globular.

No. of Coronal Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spines. Length.	Breadth.
18.	89.	42.	27.	21.	41.	56.	2.1
13.	55.	14.	13.5	10.	26.	57.	2.9
7.	18.					17.	2.5
11.	27.	12.				37.	2.3

East India Islands; Society Islands; Philippine Islands.

Echinothrix Desorii

! *Astropyga* **Desorii** AGASS., 1846, C. R. Ann. Sc. Nat., VI.
! **Echinothrix** *Desorii* PET., 1853, Monatsb. Akad. Berlin.

Ambulacra quite pointed towards abactinal region, and much narrower than in either of the other species of the genus, while the poriferous zone is extremely broad above the ambitus, nearly equalling in breadth the median ambulacral space. The ambulacra are also well raised above the general surface of the test, the sinking of the abactinal part of the median interambulacral space rendering them quite prominent. There are but two inner rows of secondary tubercles in the median ambulacral space, considerably smaller than the two exterior ones. The coronal plates are narrow, carrying near the ambitus as many as five primary tubercles on each plate; there are few secondaries irregularly scattered between them, and still fewer miliaries, and these extremely small and indistinct. The primaries are comparatively small, with an indistinct scrobicular circle and a not very prominent mammary boss. The bare part of the median abactinal portion of the test extends as far as the seventh coronal plate. On the lower surface the tubercles are more closely crowded together, quite uniform in size, decreasing but slightly towards the actinostome. Actinostome small, deeply lobed by the actinal cuts. Actinal membrane thin, strengthened by large distant limestone plates in the prolongation of the ambulacra. The abactinal system is very marked, somewhat sunken; genital plates large, broad at base, elongate, with large circular genital openings. Madreporic genital larger than the others; ocular plates narrow, elongate, separating completely the genitals and adjoining anal system for their whole length, as in the other species of the genus. Anal system nearly entirely covered by a close pavement of prominent plates of uniform size, of irregularly polygonal shape, each carrying a small tubercle; a few similar tubercles on the anal edge of the genital plates.

The spines of this species are comparatively slender, stout, solid, and quite short, not more than half the diameter of the test and somewhat bulging at centre of shaft, usually more or less banded by narrow transverse bands of greenish-yellow, though frequently the spines, as in the other species, are of uniform color.

No. of Interamb. Coronal Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spines.
22.	121.	59.	36.4	23.	43.	68.

Red Sea; Feejee Islands; Sandwich Islands.

Echinothrix turcarum

Diadema turcarum SCHYNV., 1711, Thes. Imag.

!**Echinothrix** *turcarum* PET., 1853, Monatsb. Akad. Berlin.

Pl. II^a. f. 34–48; Pl. III^a. f. 3; Pl. XXIV. f. 33–36.

This is by far the most common of the species of this genus. The test is moderately thick, flattened above and below, extremely regularly arched in profile; anal system small; genital plates but slightly elongated, and ocular plates separating them broadly rectangular, excepting the two adjoining madreporic genital, which are more or less trapezoidal. Madreporic genital in large specimens greatly exceeding the others in size, but generally in specimens already measuring $20^{mm.}$, but slightly larger or more prominent than the other genital plates; genital openings large, slightly elliptical, situated near outer extremity; anal edge of genital and ocular plates filled by secondary tubercles carrying small, slender spines similar to those of the ambulacral system, the exterior edge only of anal system carrying small plates of uniform size. The coronal plates are high, and in the largest specimens I have seen there are but three large primary tubercles upon each plate in the interambulacral system above the ambitus. The tubercles are well separated; the secondary tubercles are small, and not more than one or two for each plate, with a few miliaries filling the spaces between the primaries around the scrobicular circle. The primary tubercles are large; they are uniform in size above the ambitus, very prominent, very sharply crenulated; mammary boss very distinct, and large scrobicular circle. On the actinal surface they rapidly become smaller, and there are sometimes as many as five primaries for each coronal plate near the ambitus in large specimens; the median space, occupied by secondaries, forms an ill-defined, irregular, vertical row. Above the ambitus the primaries form three principal vertical rows. The bare median interambulacral space does not extend beyond the fourth coronal plate in the largest specimens examined. Near the abactinal system there are sometimes as many as four irregular vertical rows of small tubercles in the median space between the two outer rows. The poriferous zone is narrow above the ambitus, scarcely more than one third the width of the median ambulacral region.

The actinostome has deep broad cuts; actinal membrane thin, supported by but few small elongate limestone plates in the prolongation of the ambulacra. The spines of the interambulacral primary tubercles are long, stout, tapering, but slightly hollow, frequently equalling in length the diam-

eter of the test, and sometimes surpassing it. The verticillations are so close and regular that externally the spines appear longitudinally striated. They are generally of uniform dark color, though they are not unfrequently found light-colored with transverse bands of purplish-brown and all intermediate stages. Formerly I was led to separate this species as a distinct subgenus, Garelia of Gray, on account of the peculiar structure of the spines and the nature of the abactinal system. A better series of E. Desorii and E. calamaris show that in this genus the structure of the spines and the general aspect of the abactinal system are subject to extreme variations in both the other species, fully as great as those which serve to distinguish Garelia from Echinothrix. According to Stimpson, the color of spines when alive is of a purplish-black color, with five blue semicircular rays on the test among the bases of the spines.

The name "turcarum" has been applied to species of Diadema as well as to species of Echinothrix; to the latter, however, it seems properly to belong, though it is frequently impossible from the figures quoted to have any certainty of the genus to which the species belong.

No. of Coronal Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spines.
17.	89.	56.	24.	12.8	37.	64.
	91.					72.
13.	67.	31.2	15.8	8.	27.4	61.
12.	51.5	25.	12.5	5.8	24.1	57.
11.	22.	9.	5.3	2.	9.5	28.5

Sandwich Islands; Feejee Islands; Japan; East India Islands; Red Sea; Zanzibar.

ASTROPYGA.

Astropyga Gray, 1825, Ann. Phil.

The test of Astropyga is so thin, and the plates so loosely connected, that the whole test is more or less flexible. The test is greatly depressed. Interambulacra sunken frequently far below the bulging ambulacra near the abactinal pole. Bare median interambulacral space forking, but each plate having a deep pit brilliantly colored in life (Peters). The color is frequently retained in alcoholic specimens. Tubercles of both areas identical in structure, perforate, crenulate, arranged in many vertical rows in the interambulacra, in two in the ambulacra. The spines are shorter than in Diadema, rarely attaining half the diameter of the test in length. The poriferous

zone is broader than in Diadema, nearly as broad as the median ambulacral space; the pores are arranged in four irregular vertical rows forming steps of pores of three and one pair. The genital plates and abactinal system, with the exception of the plated anal system, not materially different from Diadema. Actinal membrane thickly covered by minute elliptical or rectangular plates, with a few larger plates carrying spines irregularly scattered. The jaws much smaller, in proportion to size of test, than any other genus of Diadematidae. Coronal plates of actinal surface and near ambitus deeply pitted when seen from inside of test, the pits corresponding to the primary tubercles.

Astropyga pulvinata

! *Cidarites* **pulvinata** LAMK., 1816. An. s. Vert.
! *Astropyga pulvinata* AGASS., 1846. C. R. Ann. Sc. Nat., VI.

Pl. III^a. f. 4; Pl. III^b. f. 4–5.

This species has a more globular, less depressed test than A. radiata, with broader bare median interambulacral spaces. It can at once be distinguished from its congener by the shape of the genital plates, which form nearly equilateral triangles, with large genital openings, and correspondingly larger rectangular ocular plates; the anal system also is surrounded by an exterior row of much larger plates, the structure of the whole abactinal system being in striking contrast to that of A. radiata, with its elongate lanceolate genital plates, and diminutive plates surrounding the anal system. The coronal plates are proportionally high, specimens of the two species of the same size in the Jardin des Plantes having thirteen plates only in A. pulvinata, while there are nineteen in A. radiata. The size of the primary tubercles is correspondingly larger, and the number of vertical rows less; specimens of same size showing eighteen rows at ambitus in radiata and only fourteen in pulvinata. The spines are also stouter, more coarsely striated, with more marked verticillations; the peculiar flat raised scrobicular circle, so characteristic of A. radiata, is replaced in this species by a gradually rising mammary boss, indistinctly defined at the base. The bare median interambulacral space covers nearly the whole of the test above the ambitus, there being but a small triangular part of the test near the ambitus covered by primary tubercles, forming short vertical rows. The actinal part of the test is much less flattened than in A. radiata, the tubercles less crowded upon it, with larger and more numerous secondaries; while above the ambitus,

owing to great breadth of the bare interambulacral space, the test is quite bare, the tubercles more irregular in size: it is not the exterior primary row of tubercles which reaches the abactinal system, but the next inner row of secondaries; in younger specimens, however, the reverse is the case. A small specimen, figured on Plate *III*[b], was remarkable for the great convexity of the edge of test, and the uniformly flattened abactinal part of the test; ambulacra rising but slightly above the median interambulacra.

The great size of the actinostome of this species readily distinguishes it from A. radiata, in A. pulvinata the actinostome being nearly a third of the diameter of the test. The vertical rows of primary tubercles of ambulacra are distant, frequently only every other plate carrying a primary, the opposite being only a secondary tubercle. In this species, as in radiata, the spots on the pits of the interambulacra (which are much less marked than in A. radiata) are also sky-blue in life, according to Mr. Bradleigh: the color in alcohol is yellowish below; above, the ambulacra are more greenish-yellow between the broad purple bare interambulacral spaces. The spines are comparatively longer than in A. radiata, in addition to being so much stouter, often considerably more than half the diameter of the test, scarcely ever longer than half the diameter in A. radiata, usually only one third; they are flesh-colored, with brownish-purple transverse bands. The dried test is of a dirty greenish-white hue, much lighter below; the median interambulacral space between the bare forks above the ambitus being as light as the actinal part of test. The comparatively narrower ambulacral zone in the abactinal part of the test is quite marked in A. pulvinata when compared to A. radiata.

In the large specimens in the Jardin des Plantes of A. pulvinata the ratio of actinostome to diameter of test was $\frac{3}{10}$, while it was $\frac{34}{140}$ in A. radiata.

The discovery of the habitat of this species is quite interesting, render-it possible to trace precisely the geographical distribution of the two species of the genus, concerning both of which many doubts existed. Mr. Bradleigh found this species at Panama; and it had previously been received at the Smithsonian from San Salvador, and at the Hamburg and Stockholm Museums from the Gulf of California, settling its geographical position beyond doubt.

No. of Tubercles.	Diameter.	Height.	Actinal System.	Abactinal System.	Anal System.
25.	88.	32.	34.	23.	13.
16.	38.	13.	17.	10.9	6.

Panama; Gulf of California.

Astropyga radiata

Cidaris **radiata** Leske, 1778, Klein, Add.

! **Astropyga** *radiata* Gray, 1825, Ann. Phil.

Pl. XXIV. f. 40.

This species, long known only from the excellent figure of Seba, is apparently quite widely distributed in the Pacific and Indian Oceans. The specimens preserved in the different collections are, however, nearly all of the same size, with the exception of a small specimen from Mauritius in the Museum collection. Test exceedingly depressed; actinal surface of test flattened; actinostome somewhat sunken, small, with moderately deep broad actinal cuts; actinal membrane strengthened by closely packed rectangular or irregularly elliptical plates covering the whole membrane; ten prominent buccal plates. The whole actinal part of test is covered by tubercles of uniform size, forming closely arranged vertical and transverse rows, one transverse row upon each coronal plate. The tubercles of both areas of the same size, diminishing very gradually in size towards the actinostome. In the largest specimens examined there were as many as sixteen vertical rows of tubercles on the actinal surface of the test near the ambitus. Outline of test seen from above is pentagonal, with rounded ambulacra extending beyond the general outline. Test at ambitus rising very rapidly, regularly arched, and whole abactinal part of test flat, the interambulacra rising but slightly towards the more or less sunken abactinal system. The ambulacra rise high above the interambulacra, especially near the abactinal system, when they increase somewhat in breadth, tapering rapidly towards the ocular plates. There are two rows of primary tubercles extending to ambitus, of uniform size, somewhat smaller than the primary rows of the interambulacra. Between most of the primaries a small secondary is intercalated in the abactinal part of the test only, the rest of the plate is loosely covered by miliaries; on the actinal surface the primaries, being closely arranged, occupy nearly the whole plate; the secondaries and miliaries in both areas are not numerous. The poriferous zone is broadest about two thirds the distance from ambitus to abactinal system, tapering rapidly to apex, but growing very gradually narrower from ambitus on the actinal surface, being very slightly petaloid near actinostome, owing to the greater obliquity and the greater size of the pores on the abactinal part of the test.

In the interambulacral spaces the whole abactinal part of the test is occupied by the broad bare forking band, separated from the poriferous zone by

one principal vertical row of secondaries extending to the abactinal system, this primary row being flanked interiorly near the abactinal system by a short parallel row of secondaries, and by an interior row of small tubercles near ambitus. The coronal plates are narrow, elongate; the median interambulacral space near ambitus contained between the narrow bare forks of the median ambulacral space, which extends to ambitus, is triangular, filled by diagonal rows of primary tubercles, forming also very irregular horizontal rows of uniform size, somewhat smaller towards median line. The tubercles of both areas are small, very distinctly crenulated, with a broad flat scrobicular circle, sharply marked, slightly raised above the general level of the test The spines are extremely slender and short compared to the great diameter of the test in the other species of this family. They are either uniformly colored or variegated, as in true Diadema, by transverse bands of lighter color. The abactinal system is large; anal plates elongate, triangular; madreporic genital slightly larger than the others; genital openings close to apex, separated by narrow rectangular ocular plates adjoining the large anal area; base of anal membrane strengthened by a few concentric rows of irregularly shaped plates, decreasing rapidly in size, carrying very diminutive spines like those of the anal edge of the genital plates.

In a small specimen the ambulacra are quite gibbous near edge, the outline is very pentagonal; the tubercles forming only vertical and not diagonal rows in the median interambulacral space (six rows). The actinal part of the test is not so extremely flattened, nor is it thickly covered by tubercles as in large specimens; the actinostome of course is very large, compared to the diameter of the test; the poriferous zone is of uniform width, the tubercles proportionally much larger; the pits extending along the sides of the bare median interambulacral space are well marked. Nothing special in the abactinal system, except somewhat less pointed genital plates.

The color of this species when alive, Peters says, is whitish-green mixed with reddish-brown. The anal system, genital plates, and bare median interambulacra are reddish, with a row of sky-blue spots placed in the pits of the coronal plates; a similar spot is found upon four of the genital plates, a large number of similar spots on the actinal membrane. Spines reddish-brown ringed with greenish-white. The dried specimens I have examined are of various tints, from a nearly uniform greenish-white test to a uniform dirty violet color, the bare median interambulacral spaces being either lighter or darker than the rest of the test.

The exact locality of this species was long doubtful. The Museum owes a specimen to the Essex Institute from Zanzibar, and several to Mr. N. Pike from Mauritius. Dr. Semper has collected it at the Philippines. Gray first gave as its habitat South America: these specimens he afterwards separated as a distinct species; they prove to be A. pulvinata, which is not uncommon in some European Museums from the Gulf of California.

No. Tub. Interambulacral.	Diameter.	Height.	Diameter Actinal System.	Diameter Abactinal System.	Diameter Anal System.	Spines.
20.	36.	11.	13.	9.2	5.	
34.	129.	30.	33.	29.	18.	45.
36.	147.	37.	37.	28.	16.	44.

Zanzibar; Philippine Islands; East India Islands.

ASTHENOSOMA.

Asthenosoma GRUBE, 1867, Jahresb. d. Schles. Ges. f. Vat. Cult.
(See Part II. p. 272.)

Asthenosoma hystrix
! **Calveria hystrix** W. THOMPS., 1869, Prelim. Dredg. Rep., Proc. R. S.
! *Asthenosoma hystrix* A. AGASS., 1872, Rev. Ech., Pt. I. p. 93.
(See Part II. p. 273.)

Pl. IV. f. 1–5; Pl. XXXVIII. f. 7–9.

Straits of Florida; Rockall and Rona.

Asthenosoma varium
! **Asthenosoma varium** GRUBE, 1867, Jahresb. d. Schles. Ges. f. Vat. Cult.

Pl. XXIV. f. 14.

The following are the principal points mentioned in Grube's notice of this species: —

"Test exceedingly flat, four and three quarter inches in diameter by one in height; differs from all other Echini in having a flexible test, owing to the limitation of the limestone deposits in the coronal plates, which leaves the edge so flexible that if the sea-urchin is lifted by the edge the whole test is bent. The spines which cover the abactinal part of the test are inserted at the base in a muscular sheath; similar spines occur on the actinal side more or less spathiform, and in addition, much larger spines, at least five eighths of an inch in length, hollow like the others, slightly curved, truncated, club-shaped, flaring into a funnel-shaped extremity. Pedicellariæ numerous, scattered over whole surface of test, many of large size. Primary

tubercles perforated. Teeth with gutter, without keel; jaws equilateral. The test is pinkish, probably darker in life, dotted with violet. The spathiform and club-shaped spines of actinal surface green. Those of abactinal part of test white, with two or three violet bands. Ambulacral zones not half as broad as the interambulacra, with one prominent vertical row of pores on outer edge of ambulacra. The heads of the larger pedicellariæ are a brilliant yellow or greenish.

China Seas.

ECHINOMETRADAE.

Family **Echinometradae** GRAY, 1855, Proc. Zoöl. Soc. London.

Gray first called attention to the affinities of the genera here included in the Echinometradae, which are understood in a somewhat wider sense, and include not only Echini with an oblique axis, but also the greater part of the Echini included by Desor in his division of Polyporidae. From the analysis of the plates of the ambulacral system, we can readily separate the Echinometradae from the Echinidae proper, the former having always more than three pairs of pores to each arc, while in the Echinidae the arcs are always composed only of three pairs. This division, although it appears a numerical one, is yet one of great physiological importance, as the mode of growth of the poriferous zone in these two families is totally unlike.

COLOBOCENTROTUS.

Colobocentrotus BR., 1835, Prod. Des. An.

The Echini of this genus do not become as large as Heterocentrotus, but have like them a solid test and elongated axis lying in the same plane as that of Heterocentrotus. The ambulacra are much broader than in the other genera of the family, the actinal surface is flat, and the poriferous zone takes consequently a great development. The tubercles are smooth, not crenulate, having only an imperfectly developed mammary boss; usually there are two principal vertical rows of tubercles in the ambulacra, forming irregular horizontal rows of several tubercles along the interambulacra. Arcs of pores composed of as many as nine or ten pairs of pores. Actinostome

pentagonal, large, sensibly indented. Auricles very slender, connected by low ridges. The whole upper surface and the greater part of test to ambitus is covered with short spines forming a close cuirass of polygonal blocks; the spines of the ambitus and lower surface are more or less cylindrical, but short and frequently spoon-shaped. Buccal membrane bare. Jaws remarkable for the large deep open foramen extending far down towards the teeth on the face of the pyramid.

Colobocentrotus atratus

Echinus **atratus** LINN., 1758, Syst. Nat.
Colobocentrotus *atratus* BR., 1835, Prod. Des. An.

Pl. III^d. f. 3; Pl. XXXVI. f. 6, 7; Pl. XXXVIII. f. 11, 12.

The whole abactinal part of the test above the ambitus is covered by a pavement of closely packed, irregularly shaped short hexagonal spines, scarcely increasing in size towards the ambitus. At ambitus the spines lengthen somewhat, become slightly spathiform or cylindrical, often club-shaped, and form a more or less regular circle of prominent spines round the edge of the test, carried by from two to three rows of primary tubercles near the ambitus. On the actinal surface the spines are short, stout, cylindrical, resembling short spines of Echinometra. The abactinal system is solid, compact, covered by large secondary tubercles carrying spines similar to those of the rest of the test, so that, when covered with spines, the abactinal system is completely concealed. The anal system is small, elliptical. Madreporic genital large, prominent; greatly exceeding in size the other genital plates. Genital plates pentagonal; ocular plates triangular, excluded from the anal system, and not projecting beyond the circular line of the abactinal system. The poriferous zone is broad; the arcs of pores composed of from eight to twelve pairs of small pores. The arrangement of these arcs is quite irregular, the vertical crowding of the coronal plates during their growth being so great that in older specimens it becomes nearly impossible to trace the pores which belong to the same arc of the poriferous zone; the whole poriferous zone being covered by short disconnected arcs, irregularly scattered, without any definite arrangement when seen from the outside.

From the ambitus the tubercles of the ambulacral zone diminish gradually in size towards the abactinal pole, and rapidly towards the actinostome; they are arranged in two very regular rows, separated by a median line of

delicate miliaries, irregularly scattered between the arcs of the poriferous zone. In the interambulacral spaces the tubercles are not arranged in vertical rows, but form irregular horizontal rows, — sometimes two on each plate; they are largest near the ambitus, and quite small on the actinal surface in the small interambulacral field left between the broad petaloid expansions of the poriferous zone. These interambulacral tubercles are not uniform in size, nor do they diminish towards the abactinal pole, but are irregularly arranged, as far as size is concerned, over the whole interambulacral zone above the ambitus. Actinostome large, pentagonal, with but slight cuts and short lips slightly prominent. The miliaries of the upper part of the test are regularly arranged round the base of the primary tubercles.

The usual coloring of the spines of this species is of a dark-violet, almost black, though there are a few specimens of a greenish tint with olive-green colored spines, which have been distinguished as a separate species (P. pedifera): they are said to come from Valparaiso and Chili; but as thus far there is no positive authority for their having been collected there, the locality of Chili and the west coast of South America can be accepted only provisionally. The original specimens of Blainville came from Oahu, and the series I have had occasion to examine does not show any features, except color, by which P. pedifera could be separated from C. atrata.

The test is thick, flattened on the actinal side, somewhat conical, with swollen edges near the ambitus, in young specimens becoming quite gibbous, and frequently almost rectangular in outline from above as well as in profile, owing to the flattening of the abactinal part of the test; buccal membrane only strengthened by few irregular plates in the continuation of the ambulacra. The ten buccal plates carry small prominent club-shaped spines.

No. of Inter. Plates.	Long. Diameter.	Height.	Diameter Act. Syst.	Diameter Abact Syst.	Width Porif Zone above Ambitus.	Diam Anal Syst.
9.	22.	8.	11.	5.5	1.	2.5
11.	36.	13.	16.	8 2	1.7	3.
11.	47.	18.	20.5	9.1	2.2	3.7
15.	59.	22.5	25.	12.	3.	4.
15.	59.	29.	25.	12.	4.	5.
16.	62.	34.	26.	13.	3.9	4.
	75. largest specimen seen.					

Zanzibar; Java; Sandwich Islands.

Colobocentrotus Mertensii

Colobocentrotus Mertensii Br., 1835, Prod. An. Des.

Pl. III^d. f. 4–5.

Distinguished at once from C. atratus by the smaller disconnected spines of the abactinal part of the test, which do not form a close pavement as in that species. The spines terminate in an irregularly spherical head, more or less separated by the miliary spines crowded in between the primary spines. The spines of the ambitus are more slender, flattened, and not cylindrical or club-shaped, as in C. atratus. The spines of the lower surface of the test are quite short, slender, cylindrical, and more uniform in size than those of the actinal surface of C. atratus. The color of the test, covered with spines, is bluish-green above and light reddish-brown on the actinal surface. The actinal membrane is thin, having a few irregularly scattered plates carrying short slender cylindrical spines; these small spines are somewhat more numerous on the ten large buccal plates.

When denuded, the test of this species is in striking contrast to the other species of the genus; and at the time of writing the Synopsis of Stimpson's No. Pacific Echini I separated this species as a distinct genus on account of the four rows of primary tubercles of the ambulacral zone. This alone is not a character of sufficient value to maintain a generic division, and the genus has here been accepted as originally proposed by Brandt.

The test is materially thinner than that of C. atratus, the outline more circular and less elliptical; the actinal surface is quite flat, slightly concave; the test in profile is conical, rising quite gradually from the ambitus, and not gibbous or swollen near the ambitus, as in C. atratus. The primary tubercles immediately on the edge of the ambitus are by far the largest, diminishing suddenly in size towards the actinostome; the narrow median ambulacral spaces left between the broad flat petaloid base of the poriferous zone are filled by two rows of small tubercles, with here and there an irregular secondary in the midst of the poriferous zone. In the interambulacral space there are three pyramidal lines of tubercles starting from the ambitus and terminating in three single vertical rows of secondaries near the actinostome. The actinostome is larger, the actinal cuts more marked, and the lips more prominent than in C. atratus.

The whole test immediately above the large tubercles of the ambitus up to the abactinal system is covered by primary tubercles of uniform size, only slightly smaller in the immediate vicinity of the abactinal system; the same

kind of tubercles closely crowd over the upper coronal plates, and the whole of the genital and ocular plates. Each coronal plate in the interambulacral zone has two parallel rows of primary tubercles, as many as eight in each row; in larger specimens, near the ambitus, these tubercles are small, with a well-marked scrobicular circle, but a very slight mammary boss, and a broad but not highly developed tubercle; the rest of the plate is covered by miliaries of uniform size closely packed together. In the ambulacral space the two median vertical rows consist of somewhat smaller tubercles closely arranged with an outer row of half the number of large tubercles, as large as those of the interambulacra, separating the base of the poriferous arcs. The miliaries which fill the median space extend laterally, but irregularly, across the extremities of the arcs of the poriferous zone. The anal system is small, deeply sunken, covered by minute plates. The ocular plates are large, triangular; the genital plates rectangular, with a large genital opening deeply notching the outer extremity of the plate. The genital ring is much broader than in C. atratus, and the difference in size between the madeporic genital and the other plates not so marked as in that species. The poriferous zone above the ambitus is much narrower than in C. atratus; the arcs are well closed round the tubercles separating them, and consist of from six to seven pairs of pores most regularly arranged, not crowded out of place, as is so constantly the case in C. atratus.

No. of Int. Plates.	Long. Diameter.	Height.	Diameter Abact. Syst.	Diameter. Act. Syst.	Anal System.
13.	54.	21.	11 5	23.	4.
	77. largest specimen seen.				

Bonin Islands; Australia.

HETEROCENTROTUS.

Heterocentrotus BRANDT, 1835, Prod. Des. An.

Test very thick, elongated, as in Echinometra; in this genus and in Podophora the longitudinal axis makes an obtuse angle with the anterior axis, the madreporic body being on the left extremity of the longer axis. The tubercles are massive, comparatively few in number, with smooth base, and imperforate. Poriferous zone very narrow above the ambitus, with pores arranged in long narrow arcs of numerous pairs, round the tubercles; below the poriferous zone widens much more than in Echinometra, becoming broader than the interambulacral space; the actinostome is very large, the actinal cuts very slight; the jaws relatively much smaller to size of

the test than in Echinometra. There is no great difference in the structure of the jaws, except that of size in Podophora, Echinometra, and Heterocentrotus. The tubercles of both areas are of uniform size, forming but two vertical rows of primaries. The radioles are very striking and very variable; the large tubercles carry club-shaped or angular massive spines, frequently twice as long as the transverse diameter of the test, apparently smooth, but in reality finely striated. Round the actinostome the spines are flattened, while on the abactinal surface the secondary spines are short, often polygonal, flattened above, and sometimes forming a closed pavement upon the upper part of test, as in Podophora. Auricles tall, slender, with large auricular opening, and connected at the base by a low ridge.

Heterocentrotus mammillatus

!**Cidaris mammillata** KLEIN, 1734, Nat. Disp. Ech.
Heterocentrotus *mammillatus* BRANDT, 1835, Prod.

Pl. IIIᶜ.; Pl. XXVI. f. 1–2, 14; Pl. XXXVI. f. 8.

The only two species of this genus I have been able to distinguish have been among the earliest species figured, though the characters upon which they have thus far been separated are not such as can be used with accuracy. The specific distinctions have been almost entirely based upon the differences of the spines, while the only permanent specific characters noticed have generally been adopted as generic distinctions.

The two species, H. mammillatus and H. trigonarius, have usually been distinguished by their spines: the former species includes all specimens with stout bat-shaped swollen spines, more or less ringed at the extremity; while the last species includes specimens with longer spines, usually tapering rapidly and more or less triangular. Blainville, Brandt, Agassiz, Valenciennes, and others have attempted to describe other species combining more or less the specific characteristics of the two: specimens having the characteristic test of the H. mammillatus, but the long triangular or tapering spines of H. trigonarius, have received the name of carinata, hastifera, Postellsii; while other specimens, having the tuberculation of H. trigonarius, but the shorter, bat-shaped, swollen, and ringed spines of H. mammillatus, have been described as violaceus, Blainvillei, etc. The remarkably fine series of specimens of all sizes and localities which I have now had the opportunity of examining leaves but little doubt that there are only two species in this genus, both having nearly the same geographical distribution, and both

species subject to extraordinary variations in the form of the primary spines, so much so that any discrimination based upon the spines alone is of no specific value. The capacity of rapid repair of the spines throws considerable light upon this point, for we frequently find specimens with bat-shaped swollen spines (H. mammillatus) where a spine is broken off at the base, and is then replaced by a long, tapering, triangular spine, identical with those thus far considered characteristic of H. trigonarius.

The test of this species is at once recognized by the small secondary tubercles of uniform size covering the whole abactinal part of the ambulacral region; the large primary tubercles of the ambulacra extending only two or three plates above the ambitus, the transition from large primaries to small secondaries being very sudden. In consequence of this structure the arcs of the poriferous zone almost meet along the median line of the abactinal part of the ambulacral system. The abactinal system is quite distinct, with small anal system; the tuberculation of the plates not as marked as in H. trigonarius. In small specimens the large triangular ocular plates are excluded from the anal system; but in large specimens there are frequently one or two in contact at apex with the anal system, the apex becoming then truncated. The primary tubercles of the ambulacral system are nearly as large as the adjoining primary tubercles of the interambulacral space. The secondary tubercles of the interambulacral region are of same size as the secondaries of the abactinal part of the ambulacral, and cover uniformly the moderately wide space left between the primaries both along the horizontal sutures and the median interambulacral line. The actinostome is comparatively larger than in H. trigonarius. The secondary spines of H. mammillatus form a sort of loose pavement, somewhat similar to that covering the test of Colobocentrotus; they cover the whole test, are small, short, usually flaring and truncated at the extremity, and give an excellent external character to distinguish temporarily these two species. (See H. trigonarius, p. 430.)

The actinostome occupies the greater part of the lower surface of the test; the tubercles rapidly decrease in size towards it from the ambitus, carrying much shorter spines, flattened and fan-shaped, with a rounded extremity in both the species of this genus. The spines of H. mammillatus vary in shape from cylindrical or bat-shaped, swollen and rounded at extremity, to long tapering triangular spines with edge more or less well defined. Coloration of spines quite varied, either uniform ash-gray or light-brown, with white rings at the

extremity, or nearly black spines of uniform coloration, with all possible combinations of these two extremes; the most common coloration being a light chestnut-color with straw-colored rings at the extremity of the spines.

The number of pores in each arc is small in this species, generally from ten to eleven pairs; while in H. trigonarius they range, in the same-sized specimens, from fifteen to seventeen pairs.

No. of Prim. Tubercles.	Long Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spine.	No. Pores.
9.	37.	17.	8.2	3.2	21.	51.	11.
9.	60.	26.	11.	4.5	32.	71.	11.
10.	74.	41.	14.5	5.7	34.	63.	11.
10.	83.	44.	15.	6.	40.	86.	11.

Red Sea; East India Islands; Feejee Islands; Sandwich Islands.

Heterocentrotus trigonarius

! *Echinus trigonarius* LAMK., 1816, An. s. Vert.
Heterocentrotus *trigonarius* BR., 1835, Prod. Desc.

Pl. III^a. f. 6; Pl. VI. f. 13.

The tubercles of the interambulacral space are placed close together, leaving but little space both in the median interambulacral space and along the sutures for the secondary tubercles. These are proportionally small, few in number, many of them reduced to miliaries. The secondaries carry spines similar in shape to the primary spines, but shorter, so that the space between the large primary spines is filled by short, sharp-pointed, secondary spines and thin, flat, miliary spines; the secondary spines are only rarely truncated, rather bevelled at the extremity, thus forming an interstitial filling of an entirely different sort from that of H. mammillatus. The abactinal system is somewhat less prominent, being more or less hidden by the closer granulation covering it. The striking specific feature is the structure of the ambulacral system. The two vertical rows of primary tubercles extend to the abactinal system, gradually diminishing in size from the ambitus towards the ocular plates, and diminishing somewhat faster than the corresponding tubercles of the interambulacral area. The most common coloration of the spines of this species is a uniform dark violet, or with a few lighter bands at the extremity of the spines. The flat, fan-shaped spines of the lower surface are generally of a lighter color and frequently banded at the extremity on the lower side of the spines. The same is also the case with the

spines of the actinal side of H. mammillatus; the top of the flat spines is usually of a darker tint, but the contrast between the pattern of coloration of the spines of the lower surface and those above the ambitus is not so marked.

No. of Prim. Tubercles.	Long. Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spine.	No of Pores.
9.	39.	19.5	7.	3.	17.	50.	15.
10.	52.	25.	10.	4.1	24.9	51.	15.
10.	69.	33.8	11.6	5.1	29.	79.	15.
10.	84.	44.5	14.		38.	125.	17.

Mauritius; Java; Sandwich Islands; Feejee Islands.

ECHINOMETRA.

Echinometra RONDEL, 1554, De Piscib. Mar. (BREYN.)
(See Part II. p. 282.)

Echinometra lucunter

! *Cidaris lucunter* LESKE, 1778, KL. Add.
! *Echinometra lucunter* BLAINV., 1834, Actin.

Pl. IV^b. f. 4; Pl. VI. f. 12; Pl. XXXVI. f. 1.

This species is perhaps the most variable species in a genus remarkable for the range of the specific characters. The general coloration of the spines ranges from a dark violet to almost straw-color tipped with violet, or uniform light pink spines tipped with yellow, and all possible gradations between this and a dark violet shaft with a yellow tip, or a light green shaft shading into a darker point tipped with yellow or a lighter shade than the body of the shaft. The milled ring is generally of a brilliant white color. The principal characteristic of this species is the shortness of the arcs composing the narrow poriferous zone, never having more than five pairs of pores, usually only four, to each arc. The outer row of ambulacral tubercles is reduced to minute tubercles, not forming prominent vertical rows as in the two American species, though in very large specimens (which have been called E. heteropora), and correspond to a variety of our common West India species which has been called E. lobata. This outer row of tubercles is more marked with a tendency to separate one of the pairs of pores from the others. The coronal plates do not greatly increase in size during growth, but increase rapidly in number. In our West India species the opposite is the case. The madre-

poric genital is but slightly larger than the other genital plates, which are uniform in size. The auricles are prominent, connected by a low interambulacral arch, flattened, anchor-shaped, with a large auricular arch. Actinal cuts well marked, somewhat rounded; actinostome larger, in proportion to the size of the test, than in any other species of the genus. The spines are proportionally short.

No. of Interamb. Tubercles.	Diameter.	Height.	No. of Pores.	Actinal System.	Abactinal System.	Spine.
11.	35.	15.5	4.	16.4	8.	21.
13.	47.	20.5	5.	21.	10.	19.
14.	51.5	23.5	5.	22.	11.	22.3
14.	56.5	28.5	5.	24.1	13.3	23.
19.	76.	44.	5.	27.5	17.	23.

Zanzibar; Red Sea; East India Islands; Japan; Sandwich Islands; Feejee Islands.

Echinometra macrostoma

Ellipsechinus macrostomus LÜTK., 1864, Bid.

Echinometra macrostoma A. AG., 1872, Rev. Ech., Pt. I. p. 116.

The following is Dr. Lütken's description of this species: —

General facies of an Echinometra. The shape is regularly oval; the actinostome and the actinal cuts somewhat larger than is usually the case in Echinometra. The ambulacral lips three times as broad as the interambulacral lips; the latter are evenly cut off, the former indented in the middle. The auricles low but strong, scarcely connected. The interambulacral tubercles in six close vertical rows; the two primary ones not much larger than the others near the ambitus, but are the only ones reaching the upper part of the test, the others being reduced to small granules; there are seventeen to eighteen tubercles in each vertical row. There are also only two rows of principal tubercles near the mouth, the two middle rows disappearing, and the two outside ones becoming very small to make room for the petaloidal ambulacra. There are about twenty-four primary ambulacral tubercles in the principal vertical rows; near the ambitus they are as large as the secondary interambulacral tubercles; in the upper part of the test, however, considerably larger than the corresponding interambulacral ones. A secondary row of tubercles is wedged in between the primary ambulacral tubercles and the poriferous zone, but disappears on the lower side, which is completely filled by the poriferous zone, the primary ambulacral tubercles dwindling down to a very small size on the actinal side. The average number of the pores in each arc is eight; this number de-

creases near the abactinal system and near the mouth (from seven to three and two). Supposing the long axis to be the longitudinal axis of the test, the madreporic genital will become the hindmost right genital plate. The anal plates cover comparatively only a small space. The longest spines are about three fourths of the transverse diameter of the test. Their color is purple, which also is the color of the test. Height, $32^{mm.}$; breadth, $66^{mm.}$; length, $70^{mm.}$, longest spines, $57^{mm.}$. The transverse diameter of the actinostome is $28^{mm.}$ and $27^{mm.}$.

The locality from which Dr. Lütken's specimen came is not known. A specimen in the Jardin des Plantes is said to come from the West Coast of Africa. Dr. Lütken thinks it more probable that New Guinea is the home of this species. This is an interesting species, representing as it does the petaloid actinal ambulacra of Echinometra; and on same grounds which inclined Dr. Lütken and myself to separate the petaloid Strongylocentrotus from the typical genus as a separate genus (Toxocidaris and Anthocidaris), Dr. Lütken separated Ellipsechinus from Echinometra. I think, from what I have shown of the development of Strongylocentrotus and Echinometra, that such a distinction of the structure of the actinal part of the ambulacra, though it may serve as a very convenient specific key for discriminating groups of species, has no generic value, as is also hinted at by Dr. Lütken himself in the remarks subsequent to his description of this species.

Echinometra oblonga

! *Echinus* **oblongus** Bl., 1825, Dict. Sc. Nat. O.
! *Echinometra oblonga* Blainv., 1834, Actin. [*Pl. XXXVI. f. 5.*

This species has not received the recognition to which it is entitled from its marked characters. Covered with the spines it is at once recognized by the short spines, their great thickness, frequently swollen in the centre of the shaft; and when denuded, by the great size of the two primary vertical rows of tubercles in the interambulacral spaces. The secondary tubercles remain small above the ambitus, and in the ambulacra are reduced to small granules. The poriferous zone is narrow; the arcs of pores nearly vertical, spreading but slightly; pores are large, not more than five in an arc. The general outline of test is elongate, elliptical, highly arched, with a thick test. The abactinal system is compact; the anal system comparatively large; the madreporic body greatly exceeding in size the other genital plates. The actinal system is nearly elliptical, with actinal cuts barely marked. The anal plates, as well

as the anal edge of the genital plates, carry prominent secondary tubercles; auricles short, retreating rapidly towards test, with low connecting ridges.

The color of the spines is uniform, varying from light pink to dark violet.

Diameter.	Height.	No of Interamb. Tubercles.	No. of Pores.	Actinal System.	Abactinal System.	Spines.
42.	25.	12.	5.	20.	8.7	
43.	23.5	12.	5.	19.9	8.5	20.
36.	19.	12.	5.	18.	8.3	17.
31.	17.8	12.	4.	14.9	6.8	
25.	12.5	10.	4.	13.	6.	15.

Sandwich Islands; Philippine Islands; Seychelle Islands.

Echinometra subangularis

! *Cidaris* **subangularis** Leske, 1778, Kl. Add.

Echinometra subangularis Desml., 1837, Syn.

(See Part II. p. 283.)

Pl. Xª. f. 2–4; Pl. XXVI. f. 11–13.

West India Islands; Brazil; Cape Verde; Bermudas; Senegal.

Echinometra Van Brunti

! *Echinometra* **Van Brunti** A. Ag., 1863, Bull. M. C. Z.

This species differs from the West India E. subangularis by the narrow arcs of the broad poriferous zone. The pores are small, placed close together, from seven to eight and frequently even nine pairs of pores in each arc, the upper pair of pores being separated from the remaining pores of each arc by the exterior row of small ambulacral tubercles. The difference in size between the median interambulacral vertical rows of tubercles is more marked than in the West India species. The abactinal system closely resembles that of the West India subangularis; but the genital openings, which are large, are placed at the very outer termination of the plates, while they are in central part of the plate in subangularis. The most striking difference is the slender auricles, with the large auricular arch connected by the narrow and low interambulacral ridge. The actinostome is proportionally small, and the actinal cuts well marked for an Echinometra; the spines, as far as I have seen specimens, are uniformly larger and more slender in proportion to the size of the test. The color in life is deep violet.

No. of Interamb. Tubercles.	No. of Pores.	Diameter.	Height.	Abactinal System.	Actinal System.	Spines.
13.	7.	42.8	19.	7.	19.	
15.	8.	64.	30.5	9.1	25.	
14.	8.	56.	24.	9.8	24.	53.
15.	8.	59.	29.	10.5	24.	42.

Peru; Panama; Gulf of California.

Echinometra viridis

! *Echinometra* **viridis** A. AG., 1863, Bull. M. C. Z., I.
(See Part II. p. 284.)

Pl. X^a. f. 1; Pl. XXVI. f. 8–10.

West India Islands.

PARASALENIA.

Parasalenia A. AGASS., 1863, Bull. M. C. Z., I.

This genus seems to be an Oligopore among the Echinometradae, having but three pairs of pores in each arc; the poriferous zones are narrow; the obliquity of the test corresponds to that of Echinometra, and the spines resemble those of the same genus; there are but two rows of tubercles, of a similar character to those of Echinometra, in the ambulacral and interambulacral areas. The great generic difference is found in the small anal system, which is closed by only four plates, as in the Arbaciadae. Buccal membrane carrying minute spines and pedicellariæ, as in Echinometra. Abactinal system large, characterized by the great development of the genital plates and the limited number of anal plates. The jaws do not differ from those of Echinometra proper.

Parasalenia gratiosa

! **Parasalenia gratiosa** A. AG., 1863, Bull. M. C. Z., I.

Pl. III^d. f. 1–2; Pl. VI. f. 14.

At first sight, large specimens of this species would readily be mistaken for true Echinometra. The test is elongate, elliptical, depressed, with two principal vertical rows of primaries of nearly same size in the ambulacral and interambulacral area. Poriferous zone narrow; pores arranged in nearly vertical arcs of three pairs. Actinostome large; actinal cuts slightly lobed; poriferous zone somewhat petaloid at actinostome in older specimens. In the interambulacral zone an irregular vertical row of secondaries separates the primary row from the poriferous zones. Median line in both areas occupied by miliaries and few small tubercles irregularly arranged in vertical zigzag lines. Abactinal system extremely prominent; anal system covered by four large anal plates. Madreporic genital much broader than other genital plates, which are extremely elongate, carrying a single small secondary tubercle near the anal system; the genital openings large, elliptical, placed

near the outer edge. Ocular plates broadly triangular, excluded from anal system. Coloring of spines seems to be fully as variable as that of Echinometra lucunter, with which it is always associated.

Young specimens of this species show remarkable differences from the young of Echinometra, reminding us somewhat of the changes undergone by Arbacia. The spines of young are comparatively far shorter, stouter; they are irregularly banded, so that, until a complete series was seen, the young were supposed to belong to a distinct species. The granulation of the abactinal system is also quite prominent in small specimens, measuring $6^{mm.}$ longitudinal diameter, while in the largest specimens examined, measuring $20^{mm.}$, the abactinal plates were nearly smooth. The contrast between the comparatively huge spines and test is so great in the small specimens that they would at first glance readily pass for young of Heterocentrotus trigonarius.

Zanzibar; Kingsmills Islands; Bonin Islands.

STOMOPNEUSTES.

Stomopneustes AGASS., 1841, Monog. Scut. Int.

This genus shows conclusively that the mere obliquity of the axis alone is not a sufficient basis to form of the Echinometradae a family among the Echinidae, as has been proposed by Gray. There are in Echinometra, in one and the same species, specimens in which the elongation of the axis cannot be traced, when we must depend upon the other characters of the genus. Stomopneustes forms the passage between Strongylocentrotus and the true Echinometradae. The test is nearly circular, although there is a slight tendency to obliquity in the axis of old specimens. The spines are long, stout, finely longitudinally striated. The actinal surface is flat, the poriferous zone becoming petaloid; while above the ambitus it is narrow, forming three irregular vertical lines of parallel rows of pores. The actinostome is small; actinal cuts scarcely marked. There are but two principal rows of primary tubercles, both in the ambulacral and interambulacral areas.

By some oversight the name of Stomopneustes, given by Agassiz to Echinus variolaris, was overlooked in the Catalogue Raisonné; and as Heliocidaris, as there constituted, has become the receptacle for all doubtful species, the restoration of this name cannot but prove justifiable, as the

species subsequently added to Heliocidaris have only increased the confusion already existing in the genus.

Stomopneustes variolaris

! *Echinus* **variolaris** Lamk., 1816, An. s. Vert.
! **Stomopneustes** *variolaris* Agass., 1841, Monog. Scut. Int.

Pl. IV^b. f. 1–3; Pl. XXIV. f. 31–32; Pl. VI. f. 11–11^a; Pl. XXXVI. f. 2, 3.

The general aspect of the test of this species with its spines is that of some varieties of Heterocentrotus trigonarius, with more slender and numerous spines. The test is thick; more or less irregular in outline when seen from above, according to the greater or less eccentricity of the axis; the auricles very slender, somewhat depressed. Abactinal system compact; anal system tolerably large, thickly covered by small plates, carrying secondary tubercles; the genital and ocular plates each carry one secondary and smaller miliaries. Madreporic genital large; the genital ring narrow, all the plates nearly uniform in size.

The denuded test can at once be recognized by the continuous groove extending along the vertical suture of the plates in the median interambulacral space. This groove is barely marked in the ambulacral region. The coronal plates are high; two principal vertical rows of primary tubercles in the ambulacral and interambulacral spaces, the ambulacral but slightly smaller than the interambulacral. The ambulacral plates are loosely covered by large secondaries and irregularly arranged miliaries extending into the poriferous zone. The poriferous zone is separated from the primary rows of tubercles by a vertical row of small tubercles; two median interambulacral vertical rows of small tubercles, irregularly arranged, separate the primary rows above the median space.

The actinostome is small; branchial notches moderately marked; tubercles of actinal surface small, but rapidly increasing towards the ambitus. Principal spines are stout, solid, tapering, coarsely striated longitudinally from the prominent milled ring; their color is olive green with purple tips. The poriferous zone is narrow above the ambitus; it is proportionally narrower in older specimens, where, owing to the great flattening of the actinal surface, the poriferous zone becomes extremely petaloid; but the number of pores in each arc is not increased, though adjoining arcs are crowded together laterally in such a manner as to give all the appearance of a great number of pores to each arc. In young specimens, as is seen by the measurements,

the actinal part of the poriferous zone is only slightly petaloid; the arrangement of the pores above and below the ambitus differing only slightly. All the specimens examined are remarkably uniform in character; only very few and slight variations have been observed in the specimens of different collections, and this species seems to be one of the best characterized among Echini.

No. of Prim. Interamb. Tub.	Diameter.	Height.	Diameter Abact. Syst.	Diameter Act. Syst.	Poriferous Zone. Width above Ambitus.	Poriferous Zone. Width below Ambitus.	
16.	62.8	28.	10.6	17.	3.2	4.6	outline of test circular.
13.	61.3	29.4	11.1	18.2	3.1	4.2	very eccentric.
11.	27.5	13.	6.1	10.5	1.7	2.1	moderately eccentric.

Mauritius; Java; Samoa.

STRONGYLOCENTROTUS.

Strongylocentrotus BRANDT, 1835, Prod. Des. An.
(See Part II. p. 276.)

Strongylocentrotus albus

Echinus albus MOLIN., 1782, Chili.
! *Strongylocentrotus albus* A. AG., 1872, Rev. Ech., Pt. I. p. 162.

Test high, thick, regularly arched, outline from above slightly pentagonal; poriferous zone broader than the median ambulacral region, which is flanked externally by two vertical rows of small primary tubercles; from their base extend horizontal rows of secondary tubercles, from five to six in a row, slightly slanting, increasing in size outwardly, which separate the arcs of pores of the poriferous zone. The median ambulacral space is closely filled with secondary tubercles, the larger ones forming two irregular vertical rows placed next to the outer large vertical row adjoining the poriferous zone. In the interambulacral space there are two vertical rows of very prominent primary tubercles extending from the apex to the actinostome, situated half-way between the poriferous zone and the median interambulacral line. The rest of the coronal plate is closely packed with secondaries and miliaries arranged in somewhat irregular horizontal rows; the secondary tubercles are slightly larger towards the median line and near the poriferous zone. Near the ambitus there are from ten to eleven pairs of pores in specimens with about thirty to thirty-three coronal plates. The anal system is large, made up of closely packed tuberculated plates, surrounded by a narrow ring of small genital and ocular plates, the latter, all except one, excluded from the anal area.

Surrounding the anal system the genital plates carry quite large secondary tubercles. Genital openings large; madreporic genital slightly larger than the other genital plates. Actinal membrane smooth, excepting a few clusters of well-separated plates in continuation of the ambulacra.

Color of test brownish; spines short, moderately stout, greenish, tipped with white.

No. Interamb. Plates.	Diameter.	Height.	Diameter Abact. Syst.	Diameter Act. Syst.	Width Porif. Zone.	Diameter Anal Syst.	Length of Spines.
24.	78.	40.	12.	20.	8.		
28.	96.	53.	15.	22.	9.		
32.	106.	55.	17.	23.	10.2	10.	10.
33.	122.	63.	18.	24.	11.		

Patagonia; Chili; Peru.

Strongylocentrotus armiger

! *Strongylocentrotus* **armiger** A. Ag., 1872, Bull. M. C. Z., III.

Pl. V^a. f. 1.

Test thin, flattened above, regularly arched below. Is at once distinguished from its congeners by the peculiar short thick swollen spines, resembling those of Echinometra oblonga. The test, when denuded, shows that the largest primary tubercles of both areas are not placed near the ambitus, but, on the contrary, within three plates of the abactinal system in the interambulacral space; they cover the abactinal part of the flattened test, decreasing rapidly towards the ambitus and actinal surface.

The genital plates are small; the genital openings large, exterior; anal system large; the plates covered by small secondary spines and tubercles. Madreporic genital much larger than the other genital plates. The two principal vertical rows of tubercles of the ambulacral region are closely packed, with secondary tubercles in the narrow median space forming only a short very indistinct row for a part of the space. Poriferous zone broad; pores arranged in well-shaped arcs. The principal row of primary interambulacral tubercles is flanked exteriorly by smaller secondaries, separating them from the poriferous zones by an irregular vertical row. There are two median vertical rows of still smaller secondaries. The coronal plates are narrow, the larger tubercles occupy nearly the whole plate; the rest of the plate is filled by small secondaries arranged round the base, with but few miliaries, both in the ambulacral and interambulacral spaces. In the ambulacral zone a few small secondaries extend between the arcs of the poriferous zone.

Actinal cuts slight. Poriferous belt of uniform width. Actinal membrane thin, with few irregular circular plates, in continuation of the ambulacral system, carrying miliaries

The color of the dried test is light violet above, whitish below; spines dark purplish-brown at the swollen part of the shaft, lighter colored at base and tip.

No. Interamb. Tubercles.	Diameter	Height.	Diameter Abact. Syst.	Diameter Act. Syst.	Diameter Anal Syst.	No. of Pores.	Length of Spine.	Diam. of Spine.
16.	52.	26.6		18.			20.5	3.1
14.	44.9	22.7	9.	16.2	4.9	7.		
13.	38.	17.8	7.5	14.	3.9	6.		

Australia.

Strongylocentrotus depressus

! *Toxocidaris* depressa A. AG., 1863, Proc. A. N. S. Phila.
! *Strongylocentrotus depressus* A. AG., 1872, Rev. Ech. Pt. I., p. 162.

The measurements and proportions are nearly the same as those of S. tuberculatus. The greater flattening of test, with narrower coronal plates and correspondingly smaller tubercles, seem however, at first sight, to characterize in a marked manner the specimens of this species.

The primary tubercles of the ambulacral and interambulacral regions are nearly of the same size. Owing to great flattening of test, the poriferous zone is frequently extremely broad, the inner and one outer pairs of pores becoming disconnected in specimens with a depressed test. This character distinguishes some of the specimens named E. disjunctus by Martens. The actinostome is apparently proportionally much larger than in S. tuberculatus, especially in the smaller specimens, but with increasing size this difference becomes less apparent.

A larger series of specimens than are now to be found in the different Museums may show that there have been too many species recognized in this genus among the species inhabiting the Chinese, Japanese, and Australian Seas, and that, as in other species of the family of Echinometradae, we find great local differences, as among the specimens of the two most common species of Echinometra which have been described under so many specific names. The want of material, however, prevents us from applying extensively to this most difficult genus the results which have reduced the number of species so materially in other genera, as we should only increase the existing confusion by attempting to consolidate species about which we know so little thus far.

The color of test is light brownish-pink; the spines are short, slender, of uniform color, somewhat darker than the test, and of very even length over the whole abactinal part of the test, giving the species much the facies of Sphaer. granularis.

No. Interamb. Tubercles.	Diameter	Height.	Diameter Abact. Syst.	Diameter Anal Syst.	Diameter Act. Syst.	No. of Pores.	Length of Spines.
23.	75.1	29.7	13.6	6.1	21.1	7.	20.
18.	45.5	17.	8.	4.	14.3	6.	13.
19.	44.	16.3	7.3	4.	14.2	5.	19.

Japan.

Strongylocentrotus Dröbachiensis

!? *Echinus* **Dröbachiensis** MÜLL., 1776, Zool. Dan. Prod.

! *Strongylocentrotus Dröbachiensis* A. AG., 1872, Rev. Ech., Pt. I. p. 162.

(See Part II. p. 277.)

Pl. IV^a. f. 2, 3, 6; Pl. VI. f. 9; Pl. IX.; Pl. X.; Pl. XXIV. f. 15–24; Pl. XXVII. f. 1–5; Pl. XXXVIII. f. 13, 14.

North European; North Pacific; Northeast Coast of North America.

Strongylocentrotus eurythrogrammus

! *Echinus* **eurythrogrammus** VAL., 1846, Voyage Vénus.

! *Strongylocentrotus eurythrogrammus* A. AG., 1872, Rev. Ech., Pt. I. p. 163.

Pl. V^a. f. 2–4.

Test regularly arched, subglobular. Two principal vertical rows of tubercles in the interambulacral and ambulacral spaces; a well-defined vertical row of small tubercles separating the poriferous zone from the primary tubercles in the interambulacral space. Two irregular median vertical interambulacral rows. Coronal plates closely crowded with small secondaries; the intervening space again filled with closely packed miliaries surrounding them. The same arrangement extends to both the median ambulacral and the poriferous zones. The main ambulacral tubercles are of the size of the median interambulacral row, and the median ambulacral rows of the same size as the secondaries filling the space between the primaries in the interambulacral space. Poriferous zone broad; pores arranged in oblique arcs separated by irregular rows of secondaries arranged obliquely, and forming indirectly a vertical line of small secondaries on the outer sides of the main vertical ambulacral row. Poriferous zone slightly diminishing in width towards the actinostome.

Abactinal system moderately compact, much like that of S. tuberculatus, but less tubercular. Anal system covered by small plates less numerous

than in S. depressus. Cuts of actinostome very moderate. Color of spines olive-brown; they are moderately stout, tapering, tipped with violet. Buccal membrane thin, strengthened in the continuation of the ambulacra by a few elliptical plates.

In young specimens the difference in size of the tubercles between the two areas is not so marked, and in large specimens the median vertical lines become regular vertical rows of secondary tubercles.

A young specimen of this species was marked in the Jardin des Plantes as labelled by Lamarck "E. tuberculatus" with a larger specimen, which would leave no doubt as to which species was intended to be named S. tuberculatus; to prevent confusion the large specimen was taken as the type of Lamarck, and the other names given to the species of this genus adopted to correspond to this assumption.

No. Interamb Tubercles.	Diameter	Height.	Diameter Abact Syst.	Diameter Act Syst.	Diameter Anal Syst	Width Porif Zone.	No of Pores.	Spine.
22.	70.	35.6	11.	21.	6.	4.8	8.	
18.	62.	31.	11.	18.8	5.6	3.6	7.	22.
17.	49.	22.6	8.2	16.		3.5	7.	
17.	42.4	21.	8.1	13.5	4.	2.4	7.	14.

Australia; Tasmania; Samoa.

Strongylocentrotus franciscanus

! **Toxocidaris franciscana** A. Ag., 1863, Bull. M. C. Z., I.

! *Strongylocentrotus franciscanus* A. Ag., 1872, Rev. Ech., Pt. I. p. 163.

Pl. V^b. f. 1–2; Pl. VI. f. 10, 10^a.

This large species is readily distinguished from its congeners by its high coronal plates; it is more closely allied to the Sandwich Island species, S. nudus, than any other. The striation of the spines is extremely fine, and the transverse grooving scarcely marked; while in the Sandwich Island species the striation of the spines is coarse and the transverse grooving more marked. In addition to this, specimens of S. nudus having already thirteen coronal plates are much smaller than specimens of S. franciscanus with an equal number of plates; unfortunately the specimens from the two localities are so different in size that a close comparison could not be instituted, and I can only call attention to the relationship of these two species at the present time, and point out their differences. Since the number of Echinoderms common to Northern Japan and the coast of California is by no means inconsiderable, it would not be at all unlikely if further materials should prove the identity of these two species. Other points of difference

are the proportionally larger size of the two principal vertical rows of ambulacral tubercles, the well-marked scrobicular circle of the primary tubercles of both areas, the proportionally smaller actinostome, and the anal system, which is completely covered by secondary tubercles; the actinal cuts are less marked, and the ambulacral region broader.

Actinal surface flattened, generally somewhat depressed from above, regularly arched in profile. There are two main vertical rows of very large tubercles, each occupying the larger part of a coronal plate in the interambulacral spaces, each flanked by a shorter row of smaller tubercles, uniting on the median line, and an irregular row of tubercles of the same size separating the principal rows from the poriferous zones. The rest of the plate is loosely filled with secondaries of different sizes, and a few miliaries arranged round the well-defined scrobicular circles of the primaries. In the ambulacral zone the median vertical line is formed of small secondaries, irregularly arranged; the rows of larger secondaries of the poriferous zone form a vertical line of tubercles of same size.

No. of Coron. Plates.	Diameter.	Height.	Diameter Act. Syst.	Diameter Abact. Syst.	Diameter Anal Syst.	Width Porif. Zone.	Length of Spines.
14.	71.3	37.	25.6	14.	8.2	4.8	56.
18.	117.6	59.1	34.5	22.	10.9	7.	53.

Formosa; Puget Sound; San Diego.

Strongylocentrotus Gaimardi

! *Echinus* **Gaimardi** Bl., 1825, Dist. Sc. N. O.
! *Strongylocentrotus Gaimardi* A. Ag., 1872, Rev. Ech., Pt. I. p. 163.

I am strongly inclined to believe that this species will ultimately prove to be nothing more than S. lividus of the Mediterranean and Azores. Unfortunately the material from Brazil is small; there are but two specimens in the Paris Museum, and we possess but few, — all nearly of the same size, varying from $25^{mm.}$ to $31^{mm.}$ in diameter. A careful comparison with specimens of S. lividus of the same size shows no differences sufficient to separate them, and which age would not modify to a considerable extent in larger specimens. In the Brazilian specimens the spines are slightly stouter, the genital and ocular plates are grooved by radiating lines from the anal system to the outer edge of the plates, — the only feature I have never seen in any of the specimens of S. lividus examined. As the Brazilian specimens are all small, other features may be developed during their growth by which these two species, evidently most closely allied, may be further distinguished; but the

want of sufficient material prevents me from having a positive view on the question. The number of primary tubercles is also greater; in Brazilian specimens there are fifteen coronal plates, while specimens of S. lividus have only twelve, — a result which may be due to the greater flattening of the test; the corresponding tubercles of the ambulacral and interambulacral tubercles are smaller, though their arrangement, as well as that of the miliaries on the coronal plates, is identical in the two species. The plates of buccal membrane are also correspondingly larger in S. lividus; no difference could be noticed in the pedicellariæ of the buccal membrane or test, as far as examined in one of the specimens. The accompanying comparative measurement of S. lividus and S. Gaimardi show the points of difference.

No. of Interamb. Tubercles.	Diameter.	Actinal System.	
15.	31.	13.	S. lividus.
17.	31.	13.1	S. Gaimardi.
14.	29.	12.	S. lividus.
17.	29.	12.	S. Gaimardi.

Brazil.

Strongylocentrotus gibbosus

! *Echinus* gibbosus Val., 1817, in Ag. Des., C. R. Ann. Sc. Nat. VII.
! *Strongylocentrotus gibbosus* A. Ag., 1872, Rev. Ech., Pt. I. p. 164.

Test slightly depressed; abactinal system sunken; abactinal region somewhat asymmetrical; the upper part of test being frequently distorted and enlarged by a parasitic crustacean * which forces its entrance into the anal system and soon attains its full size, so that small specimens of this sea-urchin are comparatively quite distorted; "it causes a dilatation and malformation of the intestine which eventually forms a large membranous cyst or sac, often in the larger specimens extending from the summit to the lower side of the shell along one side, to which it is attached by fibrous tissues. A large opening is always maintained externally, out of which the claws of the crab may be thrust; but it is apparently not large enough to allow it to go entirely out when fully grown."

The outline of the test is somewhat pentagonal; test comparatively thin. The poriferous zones are broad, each nearly as broad as the median ambulacral space, which carries two principal outer rows of primary tubercles and smaller inner rows, forming in small specimens only an irregular median vertical row. In the interambulacra there are two principal vertical rows

* Fabia Chilensis Dana (Verrill, Notes on Radiata, p. 306.)

of primary tubercles, flanked by somewhat smaller vertical rows, — one between the principal rows and the poriferous zone, the other towards the median line, — in small specimens the two median rows form an irregular median line. Both in the ambulacral and the interambulacral region large miliaries fill the coronal plates in both areas; they are arranged in regular rectangles round the primary and secondary tubercles. The spines are moderately long, slender, finely striated longitudinally. When dry, their color is olive-green, frequently tipped with purple. The ground-color of test is grayish, with more or less of a greenish tinge. The genital plates are broader than long, forming a narrow ring round the large anal system, the greater part of which is occupied by the opening left for the passage of the claws of the parasitic crab. The genital plates are not all united laterally, three of the ocular plates extending to the anal system. On the actinal side the test is quite flat, and adjoining actinal membrane the poriferous zone is not unfrequently slightly petaloid.

In large specimens there is less difference in size between the vertical rows of primary and secondary tubercles, the interambulacral area being occupied by fewer vertical rows of nearly equal sized tubercles; spines also become stouter in proportion; the anal system is less sunken, and the abactinal part of the test is much less distorted, even when attacked by the parasitic crab. In a few specimens in alcohol in the Jardin des Plantes and in the Museum Godeffroy I could see no trace of the opening for the parasitic crab. The abactinal was sunken, though but little, and the upper part of the test was not asymmetrical, otherwise these specimens free from the parasites showed no further differences, and were fully as gibbous and pentagonal in outline as specimens attacked by parasite. The actinal system is small, the cuts very slight.

No. of Interamb. Tubercles.	Diameter.	Height.	Diameter Abact. Syst.	Diameter Act. Syst.	Width Porif. Zone.
18.	37.	21.	9.	15.	3.
21.	70.	35.	15.	19.	6.

Chili; Galapagos; Peru.

Strongylocentrotus intermedius

! *Psammechinus* intermedius BARN., 1863, in A. AG., Proc. Ac. N. S. Phila.
! *Strongylocentrotus intermedius* A. AG., 1872, Rev. Ech., Pt. I. p. 164.

Outline from above pentagonal; test depressed. Poriferous zone broad, nearly as broad as the median ambulacral space; this is flanked by two

principal rows of tubercles, with two rows of smaller tubercles in the median space. Miliaries and small secondaries covering closely the coronal plates of both the ambulacral and interambulacral systems. Coronal plates broad, with five vertical rows of tubercles extending from the ambitus towards the abactinal region, forming nearly regular horizontal rows on each plate, the central row of which is the longest. Plates densely packed with secondaries and miliaries; spines short, stout, greenish, tipped with purple. Ocular plates large; genital plates small, perforated by immense genital openings placed close to the outer edge; both these systems of plates carry small secondary tubercles extending over the anal system, which is made up of small solid plates. Actinal membrane thin, covered by clusters of well-separated plates in the continuation of the ambulacral system. Actinal system small. This species was originally described from a young specimen as a Psammechinus. The irregularity of the third outside row of pores was noticed at the time of making the description. A fuller series, containing larger specimens, shows how they gradually lose this apparent arrangement in three rows of pores: the irregular outer row, at first separated by a vertical row of small tubercles from the two inner rows, gradually forms, with increasing age, an outer arc of two to three pairs of pores in continuation of the inner arc, soon assuming the regular arrangement of pores characteristic of the species or of Strongylocentrotus; the two extremities of these arcs being separated by a vertical row of tubercles.

No. of Interamb. Tubercles.	Diameter.	Height.	Abactinal System.	Actinal System.	Width Porif. Zone.	Spine.
26.	58.	29.	9.	17.	4.5	7.
23.	50.	22.	7.5	15.	3.5	6.

Japan.

Strongylocentrotus lividus

! *Echinus* **lividus** LAM., 1816, An. s. Vert.
Strongylocentrotus *lividus* BR., 1835, Prod. Des. An.

Pl. V^b. f. 3; Pl. XXIV. f. 25.

Test depressed, regularly arched. Abactinal system prominent, nearly smooth, excepting a few irregular small secondaries and miliaries near the anal system; this is large, closed by one row of large irregularly shaped plates near the genital plates, and smaller rows of plates towards the anus. In large specimens two ocular plates reach the anal system, all the others are

excluded from the anal area. In medium-sized specimens but one ocular plate reaches the anal system. Genital ring broad, plates triangular, madreporic genital much the largest, genital openings moderate; ocular plates triangular, with rounded basal corners.

Two principal vertical rows of primary tubercles both in the ambulacral and interambulacral regions; median ambulacral space filled with small irregularly arranged secondaries forming a zigzag vertical line. In the interambulacral space each primary row is flanked by a second row of smaller tubercles; of these the median rows coalesce and run irregularly to the apex, the exterior row reaching the apex as small secondaries.

Poriferous zone half as broad as the ambulacral zone, generally five pairs of pores to each arc; the arcs separated by very minute tubercles, from two to three, forming irregular oblique lines. The arcs of pores are somewhat oblique and but slightly open. The main tubercles of the ambulacral and interambulacral spaces are surrounded by irregular circles of secondaries and few miliaries forming lines between them. The coronal plates are narrow. The lower surface but slightly arched; the actinostome small; the buccal membrane thin, with a few small distinct plates in the continuation of the ambulacra. Spines long, slender, varying in color from olive to violet purplish or even yellowish tint, tipped with yellow and all intermediate shades.

No. of Interamb. Tubercles.	Diameter.	Height.	Diameter Abact. Syst.	Diameter Anal Syst.	Diameter Act. Syst.	Width Porif Zone.	Spines.	No of Pores.
23.	63.	37.2	11.	5.5	19.	3.		5.
21.	56 4	27.2	11.1	6.	18.2	2 9	19.	5.
19.	47.5	22.3	8.9	4.3	17.	2.5	19.4	5.
16.	36 6	17.5	8.	3.9	14.	2.2	17.	5.
15.	31.	14.4	7.	3.2	12.7	1.8	8.	5.
13.	19.2	6.8	4.4	2.	8.9	1.5	9.8	5.
10.	14.	6.	3.2		6.7	1.3	4.	5.

European; Atlantic; Mediterranean; Azores.

Strongylocentrotus mexicanus

! **Toxocidaris** *mexicana* (**A. Ag.**), 1863, Bull. M. C. Z.
! *Strongylocentrotus mexicanus* A. AG., 1872, Rev. Ech., Pt. I. p. 165.

This species is distinguished from S. tuberculatus, to which it is allied most closely, by its more compact anal system, narrow genital ring, and large madreporic body. The poriferous zone above the ambitus is narrow, the arcs of pores being nearly vertical. The actinostome is relatively large in this species. In the ambulacral region the two main vertical rows of primary tubercles are placed close together, the median vertical row is reduced

to an insignificant line of small secondary tubercles, similar in size to the secondary tubercles separating the median ambulacral space from the poriferous zone. In consequence of this arrangement of the tubercles and of the poriferous zone the whole ambulacral system is comparatively narrower above the ambitus than in most species of the genus. In the interambulacral region the tubercles are more nearly of uniform size; the difference in size between the primary and secondary tubercles is not very marked. The secondary tubercles occupying the rest of the coronal plates are not numerous and irregularly scattered; the miliaries are few in number. The test is thick, the spines long and stout. The actinal surface is somewhat flattened; the actinostome but slightly sunken, having large, broad cuts; actinal membrane thin, thickly covered by long elliptical limestone plates. Coronal plates high, test somewhat turban-shaped, coloring of spines dark violet.

No. of Prim. Tubercles	Diameter.	Actinal System.	Abactinal System.	Anal System.	Width Porif. Zone above Ambitus.	Width Porif. Zone on Act. Surface.
17.	68.5	26.9	12.	5.8	3.	5.2

Gulf of California.

Strongylocentrotus nudus

! *Toxocidaris* **nuda** A. Ag., 1863, Proc. A. N. S. Phila.
! *Strongylocentrotus nudus* A. Ag., 1872, Rev. Ech., Pt. I. p. 165.

Pl. XXIV. f. 26–30.

Abactinal system large, nearly smooth; one large secondary tubercle on each plate, with here and there a miliary tubercle. Test thin, regularly arched, somewhat globular. Only two vertical rows of large primary tubercles in the median interambulacral space. Coronal plates high; one indistinct median vertical line of secondary tubercles, and a row of smaller ones, separating the median interambulacral space from the poriferous zone; small secondaries loosely arranged round the scrobicular circles, filling the rest of the coronal plates; the same arrangement holds for the median ambulacral zone. Poriferous zone narrow, pores arranged in nearly vertical arcs; in the median ambulacral space two vertical rows of primary tubercles very much smaller than those of the interambulacral region. Poriferous zone slightly petaloid on actinal side. Actinostome large; actinal cuts slight; spines long, slender, tapering; test and spines colored dark violet-brown. Actinal membrane thin, with few elliptical plates in prolongation of ambulacra.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Spine.	Porif. above Ambitus.	Porif. below Ambitus.
13.	50.7	23.9	11.3	22.	5.6	22.2	2.	2.6

Sandwich Islands; Japan.

Strongylocentrotus purpuratus
! *Echinus* **purpuratus** STIMPS. 1857, Crust. Echin. Pacif. Coast.
! *Strongylocentrotus purpuratus* A. AGASS., 1872, Rev. Ech., Pt. I. p. 165.

Pl. V^a. f. 5–6; Pl. VI. f. 7; Pl. XXXVI. f. 9.

Test more gibbous than that of S. albus, to which it is closely allied, with proportionally wider ambulacral area, and test less crowded with tubercles; primary vertical row not as prominent as in S. albus, and coronal plates higher. The actinostome is also very much smaller in S. albus than in this species, and the tubercles separating the arcs of the poriferous zone, which form lateral rows, are much smaller than in the Chili species. The color of the test and spines is a brilliant violet when alive; test denuded, when dry, is greenish.

Coronal plates high; interambulacral space with six irregular vertical rows of large tubercles, the rows next but one to the poriferous zone the largest. Scrobicular circle large, tubercles not prominent, miliaries and secondaries filling the rest of the coronal plates not very closely crowded. The secondaries are large, scarcely inferior in size to the primaries. The principal vertical row of primary tubercles of the ambulacral space is nearly as large as those of the median interambulacral space. The median ambulacral space is filled by irregular vertical rows of secondaries. The tubercles of the lateral rows of secondaries separating the arcs of pores are larger nearer the inner edge. The abactinal system is distinguished by its small anal system, flanked by large ocular plates, two of which reach the anal system. The plates of abactinal system are sparsely tuberculated; genital madreporic plate pentagonal, pointed, and very prominent, much larger than the other genital plates.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Width of Porif. Zone.	Spine.
22.	68.	39.	11.	23.	7.	14.
18.	53.	26.	8.	15.	5.5	12.

San Francisco; Puget Sound.

Strongylocentrotus tuberculatus
! *Echinus* **tuberculatus** LAM., 1816, An. s. Vert.
Strongylocentrotus *tuberculatus* BR., 1835, Prod.

Pl. V^b. f. 4–5; Pl. XXXVI. f. 4.

The test is regularly arched, often somewhat flattened; the spines large, stout, sharp at extremity, and long compared to the size of the test. Anal

system elliptical, covered by small plates carrying a few minute tubercles near the edge of the anal system. Genital ring of nearly uniform breadth, slightly narrower where the ocular plates reach the anal system. Madreporic body large, pentagonal. Two main rows of tubercles in the ambulacral and interambulacral space, each flanked in the interambulacral space by a smaller one uniting in a single vertical row in the median space. The coronal plates are loosely covered by minute tubercles and few miliaries. In the ambulacral space there is one irregular central vertical row of small tubercles, with an exterior vertical row of tubercles somewhat larger, from the base of which still smaller tubercles running obliquely separate the arcs of pores. These small tubercles between the pores form in larger specimens irregular vertical rows. Poriferous zone formed of arcs of pores of from five to eight pairs of pores, more or less closed above the ambitus, and, according to flattening of the test on the actinal side, more or less petaloid. The notches of the actinostome are not deep, but broad and well defined. The color of the spines varies from dark violet to black. Test when dry and denuded is usually greenish, the lower surface whitish. Actinal membrane thin, covered by a few very distant elliptical plates.

The variations of this species show, perhaps better than any other species of the genus, that the genus Toxocidaris, which both Lütken and myself had separated from Strongylocentrotus on account of the remarkably petaloid structure of the actinal part of the poriferous zone of several of the species, can only be considered as a convenient subdivision, as we find even among the adults of this species, in which the petaloid structure of the actinal part of the poriferous zone is more marked than in any other, specimens in which the spreading of that part of the poriferous zone does not exist and in which the poriferous zone is no broader below than above the ambitus. The extent of the spreading of the actinal part of the poriferous zone depends entirely upon the greater or less flattening of that portion of the test; this flattening usually takes place only after the specimens have reached a certain size (say about 40$^{mm.}$ in diameter), and is not a structural feature, many of the specimens always retaining their globular outline, and the poriferous zone never showing any trace of flaring. A fine series of this species, collected by Mr. Dall and now in the Smithsonian collection, shows the impracticability of considering this character as one of generic value.

No. of Coron. Plates.	Diameter.	Height	Abactinal System.	Anal System.	Actinal System.	Width Porif. Zone above Ambitus.	Width Porif. Zone Actinal Side.
18.	61.	31.4	11.		18 2	4.9	5.1
18.	61.	31.	11.		17.8	4.9	5.3
18.	61.	28.6	12.	5.4	16.9	5.	5.1
17.	52.	20.8	9.	4.9	18.	3.8	4.7
18.	47.	23.7	8.		17.	4.4	4.4
16.	47.	19.2	8.9	4.5	16.1	3.	4 4
14.	36.	16.5	8.	4.	15.	2.1	2.1
13.	22.	10.1	5.2	2.6	9.	1.7	1.7

Japan; China; Australia; New Zealand.

(STRONGYLOCENTROTUS.) SPHAERECHINUS.

Sphaerechinus DESOR, 1857, Syn. Éch. foss.

Test thick; tubercles of uniform size, imperforate, not crenulate, numerous, closely packed together upon both areas. Actinal system decagonal, with deep cuts. Buccal membrane thin, generally covered by four rather prominent plates. In the poriferous zone the pores are arranged irregularly in closed arcs of from four to eight pairs.

This genus can hardly rank as more than a subgeneric division of Strongylocentrotus; the presence of deep, sharp cuts in the actinal system and the regularity of the arrangement of the tubercles, although giving to the species of this genus a striking facies, are simply quantitative characters, the value of which a better acquaintance with the subject will determine.

Sphaerechinus Australiae

! *Sphaerechinus* **Australiae** A. AGASS., 1872, Bull. M. C. Z., III.

Pl. VI. f. 18.

Test thick; outline globular, especially in young specimens, in which the outline resembles that of Amblypneustes, but as they grow older they become somewhat flattened below. The poriferous zone is narrow; the four pairs of pores are arranged in arcs of three pairs towards exterior, well separated from the inner fourth pair, — this is quite hidden among the tubercles, forming almost an independent vertical row. There are two principal vertical rows of primary tubercles in the ambulacral space on each side of the median line, forming, with the two rows of smaller tubercles separating the inner pair of pores from the others, oblique lines of tubercles from the median line to the exterior edge of the poriferous zone.

In the interambulacral space there are from six to eight vertical rows of large primary tubercles; near the median space, separating the principal rows, closely packed secondary tubercles fill the rest of the coronal plates. The coronal plates are high. The most prominent vertical row of primaries is half-way from the median line to the poriferous zone. The abactinal system is exceedingly compact and prominent; anal system large, covered by small plates carrying minute granulation; ocular and genital plates covered by secondary tubercles, genital ring narrow, genital pores large.

Color of test violet with tubercles of whitish-green. Actinal membrane covered by large prominent elliptical plates moderately closely packed together. Spines short, tolerably stout; when dry, violet at base with greenish tips.

No. of Coron. Plates.	Diameter.	Height.	Actinal System.	Abactinal System.	Anal System.	Width Porif. Zone.	Spine.
17.	25.4	16.2	10.5	5.5	3.	2.	4.5
18.	32.	23.	10.6	7.	3.3	2.6	
18.	34.8	24.8	10.6	7.9	4.	2.7	
18.	39.4	23.4	12.1	4.4	4.4	3.	7.5

Australia; Mauritius; New Zealand.

Sphaerechinus granularis

! *Echinus* **granularis** Lamk., 1816, An. s. Vert.
! *Sphaerechinus granularis* A. Ag., 1863, Bull. M. C. Z., I.

Pl. V^a. f. 7; Pl. VI. f. 16–17.

Aradas, in his memoirs on the living and fossil Echini of Sicily, has given an excellent account of the many varieties to be distinguished in this species, and which usually have served as types of as many species. The variation in the shape of the test of this species is perhaps not as great as in many of the species of Echinus, but the differences due to the mode of tuberculation are so great as readily to excuse the citations of the many synonymes of this species. Test somewhat depressed, regularly arched, slightly flattened below; sometimes test somewhat conical above. Abactinal system prominent. Anal system large, covered by comparatively few large plates, with a number of smaller ones in the centre. Genital ring narrow, madreporic genital larger than the others. The ocular plates reach the anal system; they are rectangular, elongate. The genital and ocular plates carry a few large secondaries near the anal system, with additional tubercles on the madreporic genital. Poriferous zone somewhat sunken; pores arranged in very irregular arcs,

sometimes in straight oblique lines of four pairs, or in re-entering arcs of from five to six pairs of pores, according to size of specimens. Actinostome small, actinal cuts deep. In the ambulacral zone the tubercles are slightly smaller than in the interambulacral region, forming from two to four regular vertical rows, with an irregular median vertical line, and minute secondary tubercles contained between adjoining arcs of pores along the whole poriferous zone. Small miliaries are arranged in connected rings round the scrobicular circles of the main tubercles, and also fill the space between the primary tubercles. In the interambulacral zone the vertical rows of closely packed primary tubercles are at the same time arranged in regular horizontal rows, separated by vertical and horizontal lines of miliaries and secondaries forming irregular rectangles. There are from two to twelve vertical rows of primaries, according to size of specimens, with an irregular median line. The spines are are short, stout, and, owing to the narrowness of the coronal plates, closely crowded together. They are frequently of uniform color, either violet-brown, yellowish, or tipped with white at the summit, with darker-colored shafts, or wholly white. The plates covering the actinal membrane are very large and prominent, arranged in the continuation of the ambulacra. Auricles are slender, with large auricular opening and low solid connecting ridges.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Width Porif. Zone.	Anal System.	Length of Spine.	No. of Pores.
34.	92.	63.	16.	29.4		9.	11.	5.
33.	85.1	49.	12.9	26.	4.2	7.4		6.
32.	85.2	61.		25.	4.1			5.
32.	76.4	40.3	12.1	24.		7.5	9.	6.
30.	66.2	44.	11.	21.		7.8	11.5	6.
25.	61.2	34.	10.5	21.	3.6	6.	10.8	5.
22.	49.	28.	8.4	13.5		5.1	10.1	4.
20.	34.	17.5	6.6	13.4	3.	3.9		6.
18.	25.3	13.	5.7	12.		2.4		5.
13.	12.6	6.5	2.9	7.8	1.3	1.7		4.

Mediterranean; Canary Islands.

Sphaerechinus pulcherrimus

! *Psammechinus* **pulcherrimus** Barn., 1863, in A. Agass. Proc. Phila. Ac. N. S.
! *Sphaerechinus pulcherrimus* A. Ag., 1872, Rev. Ech. Pt. I., p. 160.

Pl. VI. f. 19.

Test flattened, of medium thickness. Poriferous zone broader than median ambulacral region, containing oblique arcs of pores arranged in four pairs, separated by an oblique row of three small tubercles, with smaller miliaries

somewhat distant. Median ambulacral region flanked by two vertical rows of larger tubercles; the median space is occupied by smaller tubercles, forming in the oldest specimen examined six horizontal rows of tubercles, the exterior rows somewhat the largest. On the coronal plates the tubercles of both areas are closely packed, forming horizontal lines in the ambulacral space, and somewhat oblique lines in the median interambulacral space. Miliaries distant. In the interambulacral space there are from six to seven vertical rows in the largest specimens examined; the row placed one third the distance from the median line is somewhat more prominent than the others. The rest of the coronal plates is thickly covered by secondaries and comparatively only a few miliaries. The lower surface is quite flattened. Actinostome has sharply marked cuts. Anal system large, with prominent plates; genital ring quite narrow opposite madreporic genital, which is much larger than the remaining genital plates. Ocular and genital plates closely covered with small tubercles. Genital openings large, placed near exterior, almost at the very extremity of the pointed genital plates. Two ocular plates reach the anal area; they are rectangular and as large as the adjoining genitals: ocular pore prominent. Auricles thin, slender, with large foramen and low connecting ridge. Actinal membrane moderately covered by small longitudinal plates, with ten extremely prominent buccal plates.

No. of Coron. Plates.	Diameter.	Height.	Actinal System.	Abactinal System.	Anal System.	Width Porif. Zone.	Length of Spines.
29.	52.	27.	13.5	9.9	4.7	4.1	6.3
27.	41.	16.7	12.2	7.9	4.	4.	
24.	35.5	16.2	11.2	6.4	3.3	3.9	
20.	25.8	13.8	9.4	5.45	3.	2.9	3.8

Japan; China Seas.

(STRONGYLOCENTROTUS.) PSEUDOBOLETIA.

Pseudoboletia TROSCH., 1869, Verhdl. d. Nat. Ver. f. Rheinl. u. West.

Professor Troschel called my attention to the peculiar arrangement of the pores of some species of Echini which I had referred to Boletia, and for which he proposed the name of Pseudoboletia. The species of this genus have the general facies of Toxopneustes, the spines are comparatively longer, and the plates of the buccal membrane are thickly covered by small spines. The general arrangement of the primary tubercles is like that of Toxop-

neustes, but the outer vertical row of pores of the poriferous zone consists of twice as many pores as the inner rows, and the pores are arranged in such a way as to form arcs of four pairs of pores. The poriferous zone is comparatively no broader than in the true Toxopneustes. The actinal cuts are marked, but less prominent than in the genus just mentioned. This is an interesting genus, forming, as it were, a link between the Echinometradae and Echinidae; its position is still doubtful, and as no young specimens have yet been examined, I am unable to state anything regarding the mode of growth of the poriferous zone of this genus.

Pseudoboletia granulata

! *Boletia* granulata A. Agass., 1863, Bull. M. C. Z., I.
! *Pseudoboletia granulata* A. Agass., 1872, Rev. Ech., Pt. I. p. 153.

The tubercles of the coronal plates are very uniform in size, closely packed, covering nearly the whole of both areas, leaving bare only a small space along the median lines near the abactinal pole. The secondaries are small, far apart, and the rest of the coronal plate is closely covered by miliaries. The spines are long, scarcely tapering, of remarkable uniformity in diameter and length. The abactinal system is not materially different from that of Toxopneustes, though in this species the anal system is covered by plates of uniform size, except those immediately surrounding the anus, which are smaller. The ten large buccal plates of the actinal membrane are remarkably prominent and well developed, and carry over their whole surface spines of considerable size, closely packed together, varying from $4^{mm.}$ to $5^{mm.}$ in length. The other buccal plates also carry each from two to three similar small spines; the whole buccal membrane thus being hidden from view. The actinal cuts are slight, much less marked than in the species of Toxopneustes; the adjoining interambulacral lip is large and broad, so that the cuts appear almost like close comma-shaped openings. The pedicellariæ are similar to those of Toxopneustes, though smaller, and do not attain the size and prominence they do in that genus. The test is depressed, quite flattened both above and below, slightly conical, regularly arched in profile.

Sandwich Islands.

Pseudoboletia indiana

! *Toxopneustes* **indianus** MICH., 1862, MAILL. Bourbon, Ann. A.

! *Pseudoboletia indiana* A. AGASS., 1872, Rev. Ech., Pt. I. p. 153.

Pl. V^a. f. 8, 9.

The outline of this species is more conical in profile; test thinner; tuberculation relatively smaller, in proportion to the size of the test, compared to P. granulata. The striking difference, however, is in the proportion of the actinostome to the diameter of the test; the actinostome being considerably more than one third the diameter of the test. The actinal cuts are shorter, but broader, and the interambulacral lips of the cuts quite well developed. The actinal membrane was missing in all the specimens examined. The spines of this species are comparatively shorter than those of P. granulata, resembling more the spines of the short-spined variety of Toxopneustes variegatus. In a specimen measuring about 54$^{mm.}$ in diameter, the actinal surface is quite flat; actinostome not sunken; there are six vertical rows of primaries at the ambitus and an irregular median one. The scrobicular circles are large, with numerous small miliaries arranged parallel to the sutures of the plates and vertically between the primaries. Secondaries few in number, irregularly scattered. In the median interambulacral space the primary tubercles become very small and unimportant towards the abactinal pole, and tubercles of the exterior vertical row also diminish rapidly in size above the ambitus. In the ambulacral space there are four such primary vertical rows of tubercles, scarcely smaller than those of the interambulacral space, disappearing towards the abactinal system in the median ambulacral as in the median interambulacral space. The poriferous zone is broader than in its congener, and the coronal plates narrower. The abactinal system does not differ materially; the anal system is perhaps somewhat smaller. Ocular plates rectangular, two adjacent to anal system. Genital plates very unequal in size; madreporic genital much larger than the others. Test of a dull yellowish ground-color, with darker patch of brown round abactinal system, and a broken ring of similar brown patches in the median ambulacral and interambulacral space about half-way from pole to ambitus. A second irregular mottled ring follows the line of the ambitus. The spines are of the same tint as the test, and irregularly mottled or banded with brown.

Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	No. of Coronal Plates.
54.	23.	7.5	20.	3.6	23.

Philippine Islands; Mauritius.

ECHINOSTREPHUS.

Echinostrephus A. AG., 1863, Bull. M. C. Z., I.

The shape of the test is very striking; unlike other Echini, the greatest diameter is near the abactinal surface, which is flattened. The test slopes gradually towards the actinostome; this is small, with slight cuts. Besides the unusual outline of the test, the peculiar abactinal system is very characteristic. It is circular; the ocular plates do not project beyond the outline of the genital ring, but are wedged in between the genital plates somewhat as in Cidaris. The anal system is of moderate size, covered by a central row of large plates. The spines are long, slender, tapering, exceeding in length the diameter of the test; they have the usual structure of the spines of Echinometradae. The teeth present no peculiar features; auricles small, highly developed, connecting ridge but little prominent.

Echinostrephus molare

Echinometra **setosa** RUMPH., 1705, Amb. Rar. Kam.
!*Echinostrephus molare* A. AGASS., 1872, Rev. Ech., Pt. I. p. 119.

Pl. V^a. f. 10–12.; Pl. VI. f. 20.

Interambulacral region occupied by ten vertical rows of tubercles of uniform size, diminishing gradually in size from the point of greatest diameter towards both poles. The coronal plates towards the actinostome are high, while they are narrow and elongate towards the abactinal system. Miliaries and secondaries are irregularly scattered on the lower surface of the test, while on the abactinal surface they are arranged round the primary tubercles. There are two vertical rows of tubercles in the ambulacral space fully as large as those of the interambulacral area. They are flanked by an exterior vertical row of small tubercles extending into the poriferous zone; the median space is occupied by a few secondaries and miliaries arranged round the primaries. There are from three to four pairs of pores in each arc, the majority having but three pairs. The spines are long, slender, tapering, but gradually varying in color from flesh-color to dark-violet. The whole abactinal system is covered by distinct but well-separated secondaries. The buccal membrane is thickly covered by minute longitudinal plates only in the prolongation of the ambulacra; rest of membrane bare. Madreporic body distinct, well marked, but, as in Cidaridae, the madreporic genital plate is not more

prominent than the others. In young specimens the uniformity in the size of the tubercles of the interambulacral space is not so marked, the middle rows on each side of the median line being the most prominent.

Specimens of this species have undoubtedly been figured by Rumph as Echinometra setosa, but have since his time been generally referred to Diadema. Small specimens of this species with dark violet spines would readily pass to a casual observer as the young of Diadema, and although his original specimens are no longer accessible, yet his figure is too characteristic of this species, and too unlike any Diadema known, to pass for anything else. From the geographical range of the specimens of this species in the Museum and other collections, there is every probability that Rumph must have found it in Amboina, as it ranges from Natal to the Sandwich Islands.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Spines.
17.	28.	13.3	7.1	9.4	3.	35.
17.	23.	12.8	5.8	9.	2.6	18.

Society Islands; Zanzibar; Natal.

ECHINIDAE.

Family **Echinidae** Agass, 1846, C. R. Ann. Sc. Nat. VI. (emend.)

This family is nearly identical to the subdivision of Oligopores proposed by Desor. It is here, however, circumscribed in such a manner as to include the greater part of one of his subfamilies of Polyporidae, containing genera like Hemipedina, Phymosoma, which it may yet be advisable to separate into a subfamily when we know more respecting them from recent species than we now know. The typical genus of this family is Echinus. The mode of growth of the poriferous zone shows that the same type of poriferous zone may form either a simple vertical zone with the pairs of pores placed directly one above the other; or that one plate may be pushed out laterally between the others, so that the poriferous zone becomes composed of two vertical rows of pores; or they may be pushed out laterally to such an extent as to form three distinct vertical rows. Two of the subdivisions of this family proposed by Desor are here adopted, somewhat modified. It is impossible, however, with the scanty material at our disposal to characterize the subfamilies as distinctly, and to limit them as accurately,

as is desirable. The position of such genera as Mespilia and Amblypneustes, and of the recent representatives of Pseudodiadema and its allies, must remain very doubtful.

The subfamilies of Triplechinidae and of Temnopleuridae, into which the Echinidae are divided, both contain representatives with the above-mentioned different modes of growth of the poriferous zone. The function of the peculiar pits in the Temnopleuridae at the angles of the plates in both the areas, reduced to mere pores in some of the genera, is not known. This character in Amblypneustes is reduced to its simplest expression, and the sculpture so exaggerated in Temnopleurus and Microcyphus, already reduced materially in Salmacis, disappears entirely in Amblypneustes proper, though the general features of the genus recall strongly Salmacis, Temnopleurus, and allied genera, in the structure of the abactinal and actinal systems, while the poriferous zone and the general arrangement of the coronal tubercles are more allied to the Triplechinidae proper. In the second subfamily (Triplechinidae), the arrangement of the poriferous zone in short straight arcs of three pairs is the prominent feature, combined with a more or less sporadic and irregular distribution of the tubercles in the interambulacral area, although in some genera of this subfamily, as in Hemipedina, Phymosoma, the coronal plates of the ambulacral system are so large that the plates of the poriferous zone form a single vertical line of pores.

More abundant materials than are now accessible, especially in the Temnopleuridae, will undoubtedly greatly modify the views regarding the species and affinities of these Echini, which are here given as an approximation merely; for nowhere among the regular Echini do we find such remarkable changes due to growth as in this subfamily, to judge from the few species of which I have had occasion to examine good series of specimens.

TEMNOPLEURIDAE.

Subfamily **Temnopleuridae** DES., 1855, Syn. Éch. foss.

TEMNOPLEURUS.

Temnopleurus AGASS., 1841, VAL., Anat. Genre Ech.

Test regularly arched, somewhat conical; actinal part of test more or less concave; tubercles crenulate, imperforate, forming two principal vertical rows in each area. Pores are arranged in simple rows, but forming more or less undulating and irregularly arranged zones. The angles of the plates separated by deep lateral and vertical grooves in the ambulacral as well as the interambulacral areas. The spines are long, slender, fluted, especially those near the ambitus; those of the upper part of test are shorter, though proportionally equally fine and slender. Auricles broad, with high connecting ridges and small auricular foramen.

Temnopleurus Hardwickii

! **Toreumatica Hardwickii** GRAY, 1855, Proc. Zoöl. Soc. London.
! *Temnopleurus Hardwickii* A. AG., 1872, Rev. Ech., Pt. I. p. 166.

Pl. VIII. f. 25–28; Pl. VIII^a. f. 1–3; Pl. XXV. f. 1–2; Pl. XXXVI. f. 14.

This species has the solid test of T. toreumaticus, the same solid prominent abactinal system, with a small anal area. The abactinal system differs from it, however, in the smaller number of anal plates, and the tuberculation of the greater part of the genital and ocular plates, leaving only the extremity, where the genital opening is placed, bare. In the adult the structure of the sutures of the coronal plates in both the areas resembles more in its ornamentation that of Microcyphus; but in the younger stages it is an undoubted Temnopleurus, with sharp deep furrows; these, however, with advancing age become bevelled at the sides and extremity, so that in specimens of $28^{mm.}$ we find already the coronal plates bare along the median line, and the horizontal sutures of the plates also bare and bevelled. Each coronal plate carries but one large tubercle, forming from the ambitus a single vertical row of primary tubercles; the rest of the plate is covered by small secondaries and miliaries, irregularly arranged, and closely filling it. The bare bevelled edges of the plates form deep connected triangular pits along the me-

dian interambulacral line, with a similar vertical line of disconnected pits adjoining the poriferous zone. Below the ambitus in both areas the bare sutures and pits disappear completely; the tubercles of both areas are of uniform size, decreasing but slightly in size towards the actinostome, which is sunken and scarcely indented; actinal membrane extremely thin, completely bare, with large buccal plates. On the actinal side the interambulacral tubercles form six principal vertical rows; interstices closely filled by secondaries. In the ambulacral space there are but two principal rows, with median space filled by ten irregular rows of secondaries. In the interambulacral space at the ambitus there are two principal vertical rows of primary tubercles, nearly as large as the interambulacral primaries, decreasing very gradually towards the abactinal pole. The median space is bare; edges of plates bevelled; bare space connected from abactinal pole to ambitus; rest of plate as in the interambulacral space, closely crowded by small secondaries and miliaries irregularly arranged. The color of test is yellowish; spines are comparatively short and stout, pointed, dark violet at base and tipped with yellow at the point. On the actinal side the spines flattened, and banded with darker tints; connecting ridge of auricles very low.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spine.
42.	20.5	9.	3.5	11.5	11.
27.	12.5	6.2	2.4	8.	8.5
22.	10.5	5.4	2.3	7.9	

Japan.

Temnopleurus Reynaudi

! *Temnopleurus* **Reynaudi** Agass., 1846, C. R. Ann. Sc. Nat. VI.

Pl. VIII. f. 22–24; Pl. VIII[a]. f. 6–7.

This species does not reach the size of Temnopleurus toreumaticus. It is readily distinguished by its thin test, its comparatively larger actinostome, its immense anal system, and narrow genital ring; the facies of this species being more like Salmacis than like Temnopleurus. The furrows along the sutures of the interambulacral spaces are shorter, extending but little way from the median line, and the furrows adjoining the poriferous zone are quite small; these furrows are more or less comma-shaped, and become shallow towards the principal vertical row of tubercles. The contrast between the two primary vertical rows of tubercles and the secondaries is quite marked. At the ambitus there are three vertical rows for each plate, but the

two vertical rows flanking the principal row are made up of small secondaries extending higher up on the test than is the case in T. toreumaticus. Above the ambitus there are other secondaries arranged in arcs round the primaries on the upper part of the coronal plates. The principal row retains its prominence on the actinal surface, the secondary rows of tubercles not increasing in size. The pits are deeper and better defined on the actinal surface than above the ambitus. The abactinal system is large; genital plates heptagonal, pointed, with a sharp rectangular furrow across the base of the ocular plates, which are pentagonal, with the outer side forked; genital openings large. One ocular plate only reaches the large anal system, all others excluded. In the largest specimens sometimes three ocular plates reach the anal system. Madreporic genital much larger than the others. Anal system covered by one large plate with a number of other smaller plates decreasing towards the anus, the large anal plate more or less prominent according to size of specimen. The comma-shaped pits of the interambulacral space frequently form depressed lozenges by the junction of the furrows of the two ends of a plate, at the apex of which is placed the primary tubercle; at other times the depression is limited to a mere narrow furrow connecting the two pits, or the pits remain distinct. In the ambulacral space there are two principal vertical rows adjoining the broad poriferous zone, with two inner irregular vertical rows of secondaries. The structure of the pits is similar to that of the furrows of the median interambulacral space. The tubercles of the ambulacra are as large as those of the interambulacra. The poriferous zone is broad, though the pores are arranged nearly vertically, leaving a bare space between it and the adjacent interambulacral plates; and at the junction of the ambulacral plates and interambulacral plates there is a vertical row of small pits. The color of the test is yellowish, with light violet stripes along the median interambulacral and ambulacral zones; straw-colored below. The spines are comparatively more pointed than in T. toreumaticus, and of a dark violet at base and lighter colored at tip. The largest specimen I have seen of this species measured 40$^{mm.}$ in diameter, with spines 14$^{mm.}$ long.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spine.
23.	11.5	6.	4.	9.2	10.

Ceylon; China Seas.

Temnopleurus toreumaticus

! **Cidaris toreumatica** KLEIN, 1734, Nat. Disp. Ech.

! **Temnopleurus** *toreumaticus* AGASS., 1841, Mon. Scut.

Pl. VIII^a. f. 4–5.

This is one of the earliest species of Echini figured by the old authors, and one readily recognized. Klein's original specimen was in excellent condition, the abactinal system even being completely preserved. The anal system is of moderate size, covered by a large number of irregular plates; the original single anal plate of the young can still be distinguished from the others by its greater size in specimens measuring over $50^{mm.}$ in diameter. The genital ring is broad; all the ocular plates are excluded from the anal area; the genital plates are solid, prominent, triangular, with a well-marked genital opening towards the extremity of the irregularly triangular genital. The madreporic genital is only slightly larger than others; the ocular plates have rounded edges, with a deep pit in the angle of junction with the genital plates.

In the interambulacral space there are for each plate along the horizontal suture two deep rectangular furrows, separated by the principal row of primary tubercles. The outer pit about half as small as the pits running to the median line. At the median line the pits terminate in an almost vertical line, towards the other extremity the pits are somewhat pointed; the shape of the outer pit is the reverse, being cut off square towards the poriferous zone. The principal vertical row of primaries forms a connected line from the abactinal pole to the actinostome, while in all the other vertical rows the tubercles are disconnected by the deep pits of the sutures of the plates. There are at the ambitus of the specimen measuring $55^{mm.}$ four vertical rows of tubercles of nearly uniform size, — all, however, except the principal one diminishing rapidly in size towards the abactinal pole, — which extend a little way above the ambitus as minute secondaries. The tubercles of the principal vertical rows are surrounded by numerous minute secondaries, and near the ambitus the tubercles of the other vertical rows are similarly circumscribed. Below the ambitus the tubercles are very uniform, gradually decreasing in size to the actinostome; the furrows on the actinal surface become mere small rectangular pits along the median line and next to the poriferous zone. In the ambulacral space there are two principal vertical rows of tubercles adjoining the poriferous zone; the furrows run from the base of the tubercles to the median line, as in the median interambulacral space. These primary

tubercles are but slightly smaller than the interambulacral tubercles at the ambitus, and diminish very gradually in size towards the abactinal pole. The median ambulacral space is occupied by two vertical rows of disconnected tubercles of very unequal size, the one being as large nearly as the primaries near the ambitus, but rapidly decreasing in size, while the other is made up of minute secondaries. At the base of the primaries there are, towards the median side, a few very small secondaries. On the actinal side of the ambulacra, as in the interambulacral region, the pits become very small, the tubercles of uniform size, with irregular horizontal lines of small secondaries along the sutures of the plates. The poriferous zone is broad, with minute secondaries at the extremity of the ridges separating the pores, and on the outer edge of the zone a vertical row of somewhat larger tubercles. Auricles are high, thin, with high connecting ridge and minute foramen.

The spines are long, quite flattened, of a pink color, with three or four purplish transverse bands. Actinal membrane bare; the ten buccal plates prominent, though not large. Actinostome small, scarcely indented, somewhat sunken. The test of dried specimens is usually of a uniform drab color.

Diameter.	Height.	Abactinal System.	Actinal System.	Spine.	No. of Plate.
55.	29.	10.3	15.		23.
45.	25.	9.	14.1		
31.	17.8	5.2	9.5		
23.	11.5	5.	8.	11.8	

East Indian Ocean; China.

(TEMNOPLEURUS.) Pleurechinus.

Pleurechinus Agass., 1841, Mon. Scut.

Echini resembling Temnopleurus, but more ovoid outline, with simple pores arranged in straight or slightly undulating lines. Actinostome small, scarcely cut. Tubercles imperforate, indistinctly crenulated. The sutural impressions in the shape of deep disconnected pits, occurring not only in the angles of the plates, but sometimes three or four, even six, in a horizontal suture.

Pleurechinus bothryoides

!**Pleurechinus** *bothryoides* AGASS., 1841, Monog. Scut.

The genus Pleurechinus corresponds to the genus Opechinus of Desor, who established it to receive several very characteristic fossil species of Temnopleuridae, which D'Archiac and Haime distributed in Temnechinus and in Temnopleurus. Only a single recent species is known, and only a single denuded test, which is now a part of Michelin's collection, in the Museum of the École des Mines. It is unfortunately in such a condition that no specific description of any value can be made, and I can do nothing except to call attention to the species, totally unlike, as far as it goes, any other species of Temnopleuridae known to me. There are four deep disconnected pits of about equal size along the sutures of the plates above the ambitus; the pits are separated by primary tubercles of uniform size, forming three principal vertical rows, with two outer rows of smaller tubercles, separating the pits from the narrow undulating poriferous zone. There are two pits in the ambulacral system, with two principal outer vertical rows of primary tubercles, and two irregular median vertical rows of smaller tubercles. The test of this species is quite high, ovoid, with an outline recalling somewhat Amblypneustes. Abactinal and actinal systems, as well as spines, wanting; color of test dark violet, with white tubercles.

In the Jardin des Plantes an old specimen of Temnopleurus toreumaticus is also labelled E. bothryoides by Agassiz, which must not be confounded with the specimen of Michelin's collection. The Pleurechinus bothryoides of Agassiz, mentioned in the Anatomie du Genre Echinus, is evidently, from the short description, something very different.* This species, as well as several specimens of Temnopleurus and Amblypneustes, is marked as coming from the Galapagos; there is probably a mistake in the locality, most of the specimens having been purchased from Cumming, and are undoubtedly from the East India Archipelago or the Philippine Islands, as the same species in the British Museum, collected by Cumming, are labelled in that way.

* It is probable that the Pleurechinus bothryoides mentioned in the Anatomie du Genre Echinus is the adult Microcyphus zigzag, as there are several large specimens of M. zigzag in Michelin's collection without labels either from Michelin or from Agassiz.

TEMNECHINUS.

Temnechinus FORBES, 1852, Monog. Brit. Tertiaries.
(See Part II. p. 285.)

Temnechinus maculatus
! **Gonocidaris maculata** A. AGASS., 1869, Bull. M. C. Z., I.
! *Temnechinus maculatus* A. AGASS., 1872, Rev. Ech., Pt. I. p. 165.
(See Part II. p. 286.)

Pl. VIII. f. 1–18.

Straits of Florida; Azores.

MICROCYPHUS.

! *Microcyphus* AGASS., 1841, VAL., Anat. Genre Ech. (non Mon. Scut.).

The tubercles in this genus are small, not numerous, limited to a portion of the coronal plates, leaving in the interambulacra marginal bare spaces; in the ambulacra the tubercles are regularly arranged. The poriferous zones are narrow; pores arranged as in Salmacis, in double irregular vertical rows. The secondary tubercles, according to age, encroach more and more upon the coronal plates, leaving thus bare spaces remarkably different in specimens of different sizes; the actinal opening is angular, not indented; the abactinal system is compact; the test is stout. The spines are thin, slender, short, resembling those of Mespilia; the sutural pores are indistinct in the median interambulacral and ambulacral spaces, though frequently well defined at the junction of the poriferous zone and the interambulacral plates.

Microcyphus maculatus
! *Microcyphus* **maculatus** AGASS., 1841, VAL., Anat. Genre Ech.

Pl. VIII^a. f. 8–10.

In specimens measuring $37^{mm.}$ in diameter the test is stout, depressed from above; outline pentagonal, slightly re-entering towards the median interambulacral line. In the interambulacral space the tubercles above the ambitus are of uniform size, slightly smaller towards the median line, covering closely with the crowded miliaries placed between them, the central part of the coronal plates, and so arranged as to leave a bare lozenge-shaped area parallel with the horizontal sutures of the plates. These bare spaces rapidly decrease towards the ambitus and disappear completely on the actinal surface, where the tubercles are larger, occupying the whole of the coronal plates. The pits at the angles of the plates are well-marked on the actinal surface along the median as well as the horizontal sutural lines. In the ambulacral space the

tubercles are of uniform size, large, occupying the whole ambulacral space, with sharp, triangular pits along the median junction of the plates. The inner row of pores is separated from the outer by a vertical row of primary tubercles. The outer row of pores is somewhat sunken. The actinostome is large, only slightly decagonal, nearly circular. The general color of the test is greenish-yellow, with bright violet bare sutural areas.

In specimens measuring 29$^{mm.}$ in diameter the outline is much more pentagonal, the median interambulacral line quite re-entering; the tuberculiferous part of the interambulacral plates is reduced to an irregularly rectangular space, leaving broad bare bands along the median line, connected with the bare sutural spaces of horizontal sutures extending to the poriferous zone. The bare median space reaches nearly to the actinostome. The tuberculiferous portion of the ambulacral area is not different from the preceding stage; the poriferous zone is somewhat narrower. The anal system is small; the genital ring broad; the genital openings large, deeply cut out of extremity of the genital plates; abactinal system prominent; genital plates completely covered by small tubercles and miliaries; ocular plates small, triangular, excluded from the anal system, tuberculated on the upper edges. Sutural pits at the junction of ocular and genital plates. Anal system covered by small plates irregularly arranged, one of which is more prominent than the others. The color of the tuberculiferous part of test as in previous specimen; the bare interambulacral space is gray along the median sutures, with a dark violet edge towards the poriferous zone and along the horizontal sutures.

In younger specimens, 18.5$^{mm.}$ in diameter, the differences are considerable. The ambulacral system and adjoining tuberculiferous portion of the interambulacral system bulge out far beyond the re-entering bare median interambulacral space; the outline from above is regularly pentagonal, with rounded angles and deeply re-entering sides. The abactinal system is very large in proportion, carrying tubercles only adjoining the anal system. The genital openings are placed in crescent-shaped cuts on the outer extremity of the genital plates. The ocular plates are proportionally larger, and nearly touch the anal system; the interior angle of the ocular plates is occupied by a deep pit separating the adjacent genital plates. The tubercles of the ambulacral region only cover the outer edges, leaving a bare median space and bare horizontal sutural spaces separated by a small triangular patch of tubercles; the median sutural pits are scarcely marked in both areas, but the deep horizontal sutural pits of this stage of growth give to these smaller

specimens a totally different aspect from the adult or older stages. This stage of growth I have called Anthechinus. The tuberculiferous portion of the test is of a delicate green, while the bare spaces are of a light violet tinge. The spines are long, slender near actinostome, of transparent greenish color, with one or two narrow dark green bands near the tip of the spines. Above the ambitus they are shorter, tapering, with one or two irregularly placed dark bands. The genital plates are bare except near the anal edge, of a delicate yellowish-pink color. The ocular plates carry tubercles, as in the older stages.

In still younger stages, $13^{mm.}$, the outline is more circular, though the character of the test, as far as the arrangement of the tubercles is concerned, in both areas is the same as in the specimen just described. The pits of the horizontal sutures at the junction of the poriferous zone with the interambulacral space are deep. The poriferous zone is quite narrow, pores arranged in one regular vertical row. The pits of both areas are still more marked in younger specimens, gradually becoming obliterated with increasing size, first in the interambulacral space, and afterwards in the ambulacral space. The poriferous zone changes gradually from a regular vertical row of single pairs of pores to a slightly irregular one, then to a regular inner row with an irregular outer one, which in the oldest specimens becomes a regular outer row with a smaller number of pores than the inner one. In small specimens the spines vary in color from a light yellow to a dark green, more or less plainly banded, and the spines of small specimens, $11^{mm.}$ in diameter, are proportionally much longer above the ambitus than in the older stages. Actinal membrane bare except the ten buccal plates.

The variations in the pits and bare spaces in different stages of growth show how little reliance can be placed upon their shape and extent as far as specific determinations are concerned. Specimens of the same size, as is also the case in Amblypneustes, either having very deep median pits or pits reduced to mere rudimentary pores, while, as is well known in some species of Salmacis, the sutural pores may become deep furrows, as prominent as in any species of Temnopleurus.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	No. of Coron. Plates.
37.	23.5	7.		14.	11.
29.	22.	7.	3.5	12.8	8.
26.	18.	6.		11.2	8.
18.8	13.	6.1	3.	8.9	8.
14.5	9.9	4.9	2.	7.	7.
11.	7.9				

Japan; East India Islands; Navigator Islands.

Microcyphus zigzag

! *Microcyphus* **zigzag** Agass., 1846, C. R. Ann. Sc. Nat. VI.

Pl. VIII^c. f. 11–13.

The young only of this species was described in the Catalogue Raisonné, small specimens measuring about 12^mm. in diameter and 11^mm. in height. The outline from above is but slightly pentagonal; test moderately stout; a few spines only preserved, similar to those of Amblypneustes, but somewhat longer. Outline of test is more globular than the corresponding stages of M. maculatus. The number of coronal plates is larger, the outline of this species, especially of larger specimens, recalling more the ovoid Amblypneustes than the low pentagonal typical Microcyphus, which, however, in its youngest stages is also globular and has not yet attained a pentagonal shape. In the interambulacral space the tubercles cover, as a triangular shield, the greater part of each plate, leaving the median space and a short length of the horizontal sutures bare from the abactinal pole almost to the actinostome. One large primary tubercle occupies nearly a central position in each plate; round this are closely arranged smaller tubercles, secondaries, and miliaries, the large central tubercle forming a vertical row of distant tubercles. The median sutural pores are small, often wanting. The ambulacral system is proportionally wider than in the other species of the genus; the poriferous zone is narrow, the pores arranged in a vertical row of pores slightly undulating. In the tuberculiferous part of the ambulacra the tubercles are arranged as in the median interambulacral space, only the large tubercle of each plate is placed close to the poriferous zone, forming a regular vertical line; the median space is bare, as well as a part of the horizontal sutures; the sutural pits are better developed than in the corresponding interambulacral space, and become quite deep towards the actinostome. The abactinal system is small, somewhat raised, quite prominent; the genital and ocular plates have rounded sides; anal system covered by extremely minute plates; ocular plates distant from the anal area. Color of the test of these small specimens yellowish-brown, with darker bare median spaces.

Larger specimens, measuring 25^mm. in diameter, have not lost their ovoid outline. The poriferous zone has become somewhat broader; the pores are arranged in nearly vertical oblique lines of three pairs; the whole zone is somewhat sunken; the arcs of pores are separated by oblique lines of tubercles extending from the base of the large tubercle in each ambulacral plate.

These larger specimens differ from the smaller ones in the greater concentration of the tubercles on the plates of both areas; the median and horizontal sutures are well-defined bare furrows, sloping gradually towards the tubercles. The larger tubercles form an irregular horizontal row about the middle of each plate; the principal vertical row is no longer quite central, but somewhat nearer the poriferous zone. The bare median spaces extend fully as far along the test, nearly reaching the actinostome, to within a couple of coronal plates from it. The abactinal system shows no special change, the tubercles near the anal edge being only comparatively larger and more prominent. The actinostome is nearly circular. The poriferous zone, as well as the tuberculiferous parts of the test, are of a greenish-yellow tint, the latter standing out prominently above the dark chocolate-colored bare median spaces.

This species is interesting as forming a link between Microcyphus and Amblypneustes. It has the structural features of the former and the facies of the latter. All the large specimens I have seen are unfortunately denuded and have no actinal membrane.

This may possibly be the Cidaris bothryoides of Klein; his figure has a distant resemblance to the large specimen figured on *Pl. VIII[c]. f. 11, 12* of this Revision, and it was probably also specimens of this size to which Professor Agassiz alludes, as existing in Stokes's Collection in the Anatomie du Genre Echinus under the name of Pleurechinus bothryoides, a totally different thing from what he labelled as such in Michelin's Collection. The characteristic notice of the coronal plates as transverse costae would seem to leave but little doubt on that subject.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	No. of Coron. Plates.
25.	23.	6.8	2.8	7.5	18.
21.	19.5	5.2	2.1	6.9	18.
12.5	11.				13.
12.	11.	4.	1.5	3.6	12.

Japan; Tasmania; Philippine Islands.

TRIGONOCIDARIS.

Trigonocidaris A. Agass., 1869, Bull. M. C. Z., I.
(See Part II. p. 289.)

Trigonocidaris albida
! **Trigonocidaris albida** A. Agass., 1869, Bull. M. C. Z., I.
(See Part II. p. 289.)

Pl. IV. f. 1–7; Pl. XXXVI. f. 13.

Straits of Florida.

SALMACIS.

Salmacis Agass., 1841, Val., Anat. Genre Ech.

Test moderately thick, more or less conical; pores trigeminate; tubercles crenulated, not perforate, arranged in several vertical rows, at the same time forming regular horizontal rows. Median interambulacral spaces frequently bare; angular pores at junction of plates; abactinal system prominent; actinal system small, with slight indentations; spines fine, slender, longitudinally striated, short.

The auricles are often very high, thin, with high connecting ridges and small auricular foramen. Ambulacral system broad.

The different species of Salmacis are poorly represented in museums, and with very few exceptions the specimens are mere tests without spines and devoid of actinal membrane; but few specimens exist from which anything can be learned regarding the changes due to growth. The outline of the test of all the species varies greatly, and the specific characters thus far noticed are of course subject to doubt, owing to the comparatively limited material at our command.

Salmacis bicolor
! **Salmacis bicolor** Agass., 1841, Val., Anat. Genre Ech.

Pl. VIII^a. f. 11–12.

Test moderately thick; actinostome of moderate size, decagonal, with very slight indentations. Abactinal system large, with broad genital rings;

genital plates of uniform size; madreporic genital but slightly larger. Anal system covered by comparatively few large polygonal plates carrying small tubercles, irregularly arranged, with smaller ones between them. The ocular plates are irregularly pentagonal, small, excluded from the anal system; the genital plates carry a ring of secondary tubercles near the anal system. Interambulacral space covered by tubercles very uniform in size, arranged in vertical and horizontal rows decreasing gradually from the ambitus to the abactinal pole; the vertical rows adjacent to the poriferous zone are slightly larger than the others, as many as twelve vertical rows of ambitus at specimen measuring $50^{mm.}$ in diameter. The coronal plates are narrow; the plates carry in addition to the primary spines an irregular horizontal row of small granules above the primary tubercles. In the ambulacral space the two primary vertical rows adjacent to the poriferous zone are as large as the interambulacral primaries; the median space is filled with from four to five irregular vertical rows of somewhat smaller tubercles. In large specimens the second inner vertical rows are frequently as large and regular as the outer row. On the ambulacral plates a few granules occupy the upper part of the coronal plate. On the actinal side of the test we find that at the ambitus and below it the tubercles rapidly increase in size, and cover the whole actinal surface close to the actinostome with tubercles of very uniform size arranged in regular horizontal rows, but becoming slightly smaller towards the actinostome. The median ambulacral tubercles, however, diminish gradually in size towards the actinostome. The poriferous zone is broad; pores large, regularly arranged in arcs of three pairs. The spines of the test above the ambitus are short, pointed, slender, of a greenish color, banded with five or six transverse bands of violet. The spines of the actinal surface are much longer and broader, frequently flattened, gradually tapering and blunt at the extremity, and similarly banded to the spines above the ambitus. The color of the test, when dry, is yellowish-brown.. The pores at the median junction are small, and the horizontal sutures of the coronal plates slightly furrowed.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System	Spine.	No. of Coron. Plates.
53.	35.	10.	5.	11.7		31.
44.	27.	9.1	5.4	12.	15.	27.

Red Sea; Indian Ocean; Mozambique.

Salmacis Dussumieri

! *Salmacis* **Dussumieri** AGASS., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VIII^b. f. 7–8.

The outline of this species is quite different from any other in the genus; the test is flattened, somewhat pentagonal from above, and at first glance recalls Temnopleurus Reynaudi, having very much the same coloration. It has, however, no pits, but simply small sutural pores. Gray has established for this species the genus Toreumatica, but I cannot agree with him in maintaining it even as a subgenus of Salmacis. None of the specimens I have examined carry spines. The actinostome is small, with short, rather sharp cuts deeply sunken. The whole actinal surface carries large uniform tubercles, which diminish very rapidly in size from the ambitus to the actinostome, separated by horizontal rows of miliaries closely packed, and also miliaries in the median space. The abactinal system resembles that of S. sulcata; the genital ring is narrow, and one or two of the ocular plates are in contact with the anal system.

Above the ambitus the median interambulacral space is bare, and is flanked near the poriferous zone by one principal vertical row of large primary tubercles; the rest of the coronal plate having from two to three secondaries, and a few miliaries irregularly scattered over it. Near the ambitus there are three vertical rows of primaries on each side of the median line, the row immediately adjoining the poriferous zone extends some way towards the abactinal pole. There are in the ambulacral space two outer primary rows of tubercles next the poriferous zone; the median space is bare, with few scattered miliaries, except near the ambitus, where there are two or three additional short vertical rows of primaries.

Diameter.	Height.	Abactinal System.	Actinal System.	No of Coron. Plates.
44.	19.	9.1	10.	25.
41.	18.	8.8	9.	25.

China Seas.

Salmacis globator

! *Salmacis* **globator** AGASS., 1846, C. R. Ann. Sc. Nat., VI. [*Pl. XXXVIII. f. 23.*

This species is interesting as forming a transition between Salmacis and Temnopleurus, showing these two genera to be much more closely related than would appear from the comparison of such extreme forms of each as

S rarispina and T. toreumaticus. In each genus we find species recalling, by their general appearance, some species of the other, — Temnopleurus Reynaudi, at first sight, recalling more a Salmacis than a Temnopleurus, as Salmacis globator reminds us more of Temnopleurus than of Salmacis, — and it may be advisable hereafter, with additional material, to limit these genera somewhat differently than they are here defined; as, however, we know, from the little the young of these species teach us, that they are subject to very great changes during growth, it would only have added confusion to a group which presents already sufficient difficulties to have adopted or modified the genera thus far proposed by Girard and myself, I have preferred to retain the old subdivisions till our material enabled us to make a Revision upon a sounder basis.

The test of this species is quite stout; coronal plates narrow; the tubercles of the whole test are remarkably uniform in size, though somewhat larger on the actinal side, forming, as in S. bicolor, regular horizontal and vertical rows; the upper part of the coronal plates is occupied by small miliaries closely packed, and extending between the primary tubercles. In specimens measuring $60^{mm.}$ there are as many as six vertical rows on each side of the median line at the ambitus in the interambulacral, and three in the ambulacral space. The poriferous zone is comparatively narrower than in the other species of Salmacis, the pores being closely crowded together in the short arcs. The prominence which the furrows of the horizontal sutures of plates, extending from the poriferous zone to the median line above the ambitus, take, is remarkable; in some cases they become pits as deep as any we find in Temnopleurus, and are disconnected, as in that genus, near the poriferous zone, while in other specimens they are barely marked; generally the furrows are more marked near the median line of both areas. The actinostome is sunken; the tubercles of the actinal surface do not decrease rapidly towards the actinostome; there are no sutural furrows on the actinal side; the actinal cuts are mere broad undulations. The spines are short, stout, pointed, except a few longer spathiform spines near the actinostome; they are dark green at the base, tipped with violet. The color of dry denuded tests is grayish, tinged with light purple; the sutural furrows of lighter color, and yellowish on the actinal surface. The abactinal system is remarkable for its large genital plates and comparatively minute ocular plates excluded from the anal system. The genital openings are large, elongate. The genital plates carry a few small tubercles on the anal edge; anal system covered by large

plates carrying tubercles, and diminishing rapidly towards the anus. The auricles of this species are remarkably broad, thin, with a high connecting ridge.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spines.	No. of Coron. Plates.
70.	52.	12.		21.		36.
67.	46.	12.5	5.4	19.		33.
60.	36.	11.		17.8		33.
48.	33.	8.	4.8	13.	8.	27.
22.	13.8	5.	2.	9.1	4.	18.

Australia.

Salmacis rarispina

! *Salmacis* **rarispinus** AGASS., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VIII^b. f. 4–6.

Test usually quite conical, much thinner than in other species of Salmacis. The coronal plates are comparatively higher. The abactinal system large, with a broad genital ring and genital plates of equal size. Ocular plates large, pentagonal, completely excluded from the large anal system; this is covered by large plates decreasing rapidly in size towards the anus, carrying, as well as the anal edge of the genital plates, small secondaries. In the interambulacral space above the ambitus the primary tubercles are small, nearly of uniform size, far apart, forming only two continuous vertical rows next to the poriferous zone. The other tubercles are more irregularly arranged, forming disconnected vertical rows, and leaving the greater part of the median interambulacral space bare. The coronal plates above the ambitus are comparatively bare, owing to the distance of the primary tubercles, and the small size and small number of the miliaries which are extremely distant. The test above the ambitus is a grayish color, with lozenge-shaped figures along the horizontal sutures similar to the pattern so frequently found among species of Echinus. In the ambulacral space the arrangement of the primary tubercles and the pattern of coloration are similar to that of the interambulacral; there are two outer regular vertical rows and two inner irregular disconnected rows of primaries. On the actinal side the tubercles are large, quite closely packed, gradually diminishing in size towards the actinostome, which is small and quite sunken, almost circular. The spines are long, slender, pointed, somewhat flattened, straw-colored, with from seven to eight brilliant purplish transverse bands. Sutural pores quite minute.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Spines	No. of Coron. Plates.
20.	13.5	4.8	2.	8.	17.	20.
60.	46.	13.	6.	12.2	28.	31.
61.	43.	11.	5.9	13.8		30.
72.	52.	14.5	8.	17.		34.

Philippine Islands; Siam; China.

Salmacis sulcata

! *Salmacis* **sulcatus** AGASS., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VIII[b]*. f. 3; Pl. VI. f. 6.*

This species is very closely allied to S. bicolor. It differs from it in having a more deeply lobed and slightly larger actinostome. The abactinal system is less prominent; the genital plates are pointed, shallower; the ocular plates approach the anal system, and carry two prominent tubercles on each side of the ocular pore; the anal system is large. In the interambulacral space we find one of the vertical rows above the ambitus much larger than the others; the remaining part of the coronal plates is occupied by small secondaries and miliaries, forming two somewhat irregular horizontal rows, sometimes three, near the ambitus, in striking contrast with the uniform tuberculation of S. bicolor. The tubercles of the actinal side are uniform in size and larger than those above the ambitus, as in S. bicolor, but not as closely crowded and with larger secondaries. In the ambulacral space the two vertical rows of primaries adjacent to the poriferous zone are comparatively smaller than those of the interambulacral region. The horizontal furrows of the coronal plates are better defined in this species than in S. bicolor. The sutural pores are slightly larger. The test, when dry, is yellowish-green, with spines of the same color at the base, tipped with dark violet; the spines are comparatively sharper and more uniform in size above and below the ambitus than in S. bicolor. Actinostome somewhat more sunken also than in that species. Madreporic genital much larger than the other genital plates. In other specimens the spines were cream-colored, banded transversely by five or six narrow dark brown lines. Young specimens of Salmacis sulcata figured by Savigny would readily be mistaken for young Echinus, as the difference in size in the vertical rows of the primary tubercles is not seen at that age.

Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	No. of Coron. Plates.
48.5	27.	9.	5.	14.5	30.
54.	30.8			16.	29.
61.	40.5			15.	32.
67.	40.			16.5	35.

Australia; Philippine Islands; Mozambique; Red Sea.

MESPILIA.

Mespilia DES., 1846, in AGASS., C. R. Ann. Sc. Nat., VI.

Echini with thin globular test; tubercles small, imperforate, and crenulate; the median areas bare; tubercles pushed to the sides of the coronal plates on the upper surface of the test, on the actinal surface they are closely packed together. Sutural pores in the angle of the coronal plates. Poriferous zone broad, pores arranged in two irregular vertical rows; the outer row has fewer pores than the inner row. Buccal membrane bare; abactinal system moderately large; spines hair-like, very slender, not long; the bare spaces of the ambulacral and interambulacral areas closely packed with innumerable pedicellariæ, supported upon short stems. Actinostome decagonal, of rather small size. Auricles are high, with low connecting ridge and large auricular foramen. The pyramid of the teeth is remarkable for the small foramen on the upper part of the face of the pyramid.

Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Spines.	No. of Coron. Plates.
46.	33.	9.	13.	6.2	9.	42.
34.	25.				7.	
27.	19.	6.	9.9	3.5	6.	29.

Mespilia globulus
Cidaris **granulata** LESKE, 1778, KL. Add.
!**Mespilia** *globulus* AGASS., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VI. f. 1; Pl. VIII^a. f. 13–14; Pl. VIII^c. f. 14; Pl. XXXVIII. f. 22, 22^{a-c}.

The only species thus far known of this genus does not reach a large size, and when covered with spines is a most graceful Sea-urchin. The broad, bare areas of the interambulacral spaces are of a dark green color (in alcohol), separated by a belt of closely packed spines of uniform length; the spines are of a light green at the base, and towards the extremity banded with white and purple. Between the broad belts are the narrower bare belts of the ambulacral areas, separated from the poriferous zones by narrower zones of spines. The bare spaces reach the ambitus; the whole lower surface is uniformly tuberculated and covered by rather larger and stouter spines than those above the ambitus. Anal system large, covered by a small number of rather large plates carrying each a minute tubercle; genital ring narrow; genital openings large; genital plates of uniform size, laterally elongate,

pentagonal, adjacent, excluding completely the small triangular ocular plates from the anal system. Madreporic genital much larger than the others. In both the median ambulacral and interambulacral spaces the bare part of the test is sharply separated from the tuberculiferous part of the plate which occupies about half the outer part. Each plate in the interambulacral space carries two nearly horizontal rows of tubercles, one of primaries, and one above it of secondaries; below the ambitus the secondaries are much smaller in proportion than above the ambitus. The arrangement of the tubercles is the same in the ambulacral space, where of course the horizontal rows are shorter, and in quite large specimens there are not more than from two to three tubercles in each row. The pores at the angles of the plates in the median line of both areas are small, but sharply cut. The tubercles of both areas are of the same size, and both above and below the ambitus the primaries and secondaries are remarkably uniform in size. The pores at the angles of the plates between the poriferous zone and the interambulacral plates are not as well defined as the median pores. The whole bare space of both areas is finely granular. This genus seems intermediate between the Temnopleuridae proper and Amblypneustes, which forms the passage between the sculptured and pitted Echinidae to the Echinidae proper.

Japan; Philippine Islands; Sandwich Islands.

AMBLYPNEUSTES.

Amblypneustes AGASS., 1841, Mon. Scut.

Abactinal axis as long as the transverse, sometimes even greater; test extremely thin; abactinal system small, compact, but quite prominent; actinostome small, without cuts. Poriferous zones broad, forming vertical rows or short trigeminal arcs of well-defined pores. Ambulacral zone broad; tubercles of both areas identical in size; median spaces frequently bare; pores very slender and comparatively small; auricles delicate; there are frequently sutural pores at the angles of the plates in both areas; spines very fine, slender, short, far apart; no regular ambitus; outline more or less ovoid; auricles slender, tall, scarcely touching over the large auricular foramen; high connecting auricular ridges.

Amblypneustes formosus

! *Amblypneustes* **formosus** VAL., 1846, Voyage Vénus.

Pl. VIII'. f. 1-2.

Test thin, ovoid, remarkable for the distinctness and number of the median sutural pores. The tuberculation is similar to that of A. ovum. The median spaces of both areas are quite bare; the secondaries of the interambulacra between the principal primary vertical row are larger and more closely crowded in this species, while those extending towards the median line are smaller and more numerous, forming regular horizontal lines; the rest of the plate is filled by small distant miliaries irregularly scattered. As many as ten or eleven tubercles in each plate in the interambulacra, and from four to five in the ambulacra. There are as many as eight to ten sutural pores for each plate along the median line, from which diverge, more or less parallel to the horizontal sutures, shallow pores extending as far as the principal vertical row, forming a most delicate sculpture over the median part of the ambulacral and interambulacral plates, extending from the abactinal region nearly to the actinostome. The abactinal system is small; the genital ring narrow; the madreporic genital greatly larger than the other genital plates; genital openings large. Poriferous zone narrow, smooth, without either secondaries or miliaries. Actinostome small. Spines long, slender, pink at the base, frequently tipped with red or orange, or simply of a darker shade of pink. The test is beautifully ornamented by dark, chocolate-colored lozenge-shaped figures, upon adjoining angles of which are seated the primary vertical tubercles, extending from the poriferous zone with the longer point towards the median interambulacral line. Similarly shaped patches, much smaller, extend from the inner part of the poriferous zone towards the median ambulacral line. Poriferous zones are yellowish, the rest of the test is of a delicate brownish-pink color. Slight pits in the ocular plate as in A. pentagonus.

Diameter	Height.	Abactinal. System.	Actinal System.	Width Porif. Zone.	Spines.	No. of Coron. Plates.
31.	28.	6.	9.5	1.9	5.	28.
29.	31.	5.4	8.4	1.9		26.
27.	24.2	5.	8.	1.5		25.
23.	22.6	4.4	7.	1.2	4.5	21.

Australia; New Zealand.

Amblypneustes griseus

! *Echinus* **griseus** BLAINV., 1825, Dict. Sc. Nat. O.

! **Amblypneustes** *griseus* AGASS., 1841, Monog. Scut. [*Pl. XXXVIII. f. 20, 21.*

Test comparatively stout, somewhat depressed, remarkable for its broad poriferous zone and the size of the abactinal system. The tubercles in the interambulacral space form one regular horizontal line in the centre of each coronal plate; the principal vertical row of primary tubercles is not as marked as in A. ovum, the tubercles are more uniform in size, and extending to the median line, leave but a very narrow space covered by granules. The sutural pores are more distinct, and the median ambulacral space is comparatively narrower than in A. ovum; the broad poriferous zone is frequently somewhat sunken. The secondaries and granules between the pores in the poriferous zones are quite prominent, and form two more or less regular vertical rows; the tuberculation of the median space is close; the vertical arrangement distinct near the poriferous zone, but less marked towards the median line. There are as many as seven tubercles in a horizontal row in the interambulacra for each plate, and half the number in the ambulacral space. The color of the test varies from a greenish-yellow to an ashy color; poriferous zone brighter colored. Ornamentation of the median lines of both areas very indistinct; abactinal system with large anal system. Spines comparatively stouter and less tapering than those of A. ovum; light green or violet, tipped with darker color or orange.

Diameter.	Height.	Abactinal System.	Actinal System.	Width Porif. Zone.	Spines.	No. of Coron. Plates.
47.5	35.1	10.5	15.	3.5		33.
44.2	34.2	10.	14.	3.1	5.	31.
35.	29.9	8.5	12.2	2.4		27.
30.	22.5	8.	11.3	2.4		26.
21.5	12.	5.	8.	1.8	4.	25.

Australia.

Amblypneustes ovum

! *Echinus* **ovum** LAMK, 1816, Ann. s. Vert.

! *Amblypneustes ovum* AGASS., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VIII^c. f. 3, 4.

Test thin; outline regularly ovoid; sutural pores of median lines both in the ambulacral and interambulacral spaces wanting or rudimentary. In the interambulacral space there is one primary vertical row of tubercles, with smaller tubercles forming one to two irregular horizontal lines on the coronal

plates; these secondary tubercles are largest between the principal vertical row and the poriferous zone, quite small towards the median line or wanting, leaving the median interambulacral space nearly bare or filled with minute distant granules. The ambulacral space is narrow, with narrow poriferous zones; pores arranged in short oblique arcs of three narrow pairs of pores. Adjacent to the poriferous zone, in the median ambulacral space, there is a prominent vertical row of primary tubercles closely packed, as large as the primaries of the interambulacral space; the median space is more or less bare; comparatively large secondaries form from one to two irregular vertical rows next to the outer primary row. The general color of the test is light olive-green, with darker zigzag lines parallel to the median sutures in both the ambulacral and interambulacral areas; these lines are especially distinct and numerous near the abactinal pole, they diminish gradually in intensity and number towards the actinostome. From the median line horizontal lines of the same color extend sometimes along the sutures, and have a tendency to form indistinct lozenge-shaped figures near the poriferous zone, on the outer edge of the interambulacral area. The primary tubercles of both areas are considerably larger immediately round the actinostome. A dark brown band often extends from pole to pole on the inner side of the poriferous zone adjoining the median ambulacral space. The spines are short, slender, pointed, of a dark green color at base, tipped with red, violet, or orange. The abactinal system is smaller than in A. griseus; the ocular plates excluded from the anal system; genital openings large, notched out of the plate at the very extremity of the genital plates. Anal system moderately large; genital plates of uniform size. The minute miliaries and secondaries scattered through the poriferous zones form an irregular vertical row.

Diameter.	Height.	Abactinal System.	Actinal System.	Spines.	Width Porif. Zone.	No. of Coron. Plates.
37.	37.5	7.5	11.	5.1	1.8	27.
49.5	47.	8.4	13.		2.9	31.

Amblypneustes pallidus

! *Echinus* **pallidus** LAMK., 1816.

! *Amblypneustes pallidus* VAL., 1846, Voyage **Vénus.**

A better series of specimens than now exists in any of our Museums will, I think, show the identity of A. pallidus and A. formosus. The peculiar pattern of coloration so remarkable in A. formosus, as well as the delicate sculptures of the median ambulacral and interambulacral spaces, exists in

what has been called A. pallidus, but so slightly developed that it would readily escape attention, and, owing to the different ground-color of the test, — a yellowish or light violet, — the facies of this species is apparently quite different at first; the coloring of the test is very uniform, and the brilliant white tubercles stand out prominently upon the even background of the test. The presence of secondaries and small miliaries in the narrow poriferous zone, as well as the less numerous median sutural pores, and the greater uniformity of the tubercles and their more irregular arrangement, makes me hesitate to separate these two species, which I am convinced will prove identical, though the intermediate links are as yet wanting. The differences I have pointed at above are the only ones by which I can distinguish them. The scarcity of good series of Amblypneustes in our collections makes it difficult to give a satisfactory account of them; and as they are extremely variable in coloration, pattern, ornamentation, proportions of test, what I give here concerning them must be taken only as a preliminary attempt to unravel this difficult genus.

Australia; Feejee Islands.

Amblypneustes pentagonus

! *Amblypneustes* **pentagonus** A. Agass., 1872, Bull. M. C. Z., III.

Pl. VIII^c. f. 7–8.

Unlike the other species of Amblypneustes, the outline of the test from above is pentagonal; the ambulacra projecting considerably beyond the concave interambulacra. The coronal plates are high, not half as numerous as in other species of the genus of the same size. There is but a single primary vertical row of tubercles both in the ambulacral and in the interambulacral spaces, with remarkably well-defined and somewhat raised scrobicular circles, as in some species of Temnopleurus; secondary tubercles few in number, very irregularly scattered; sutural pores small, limited to the angle of the plates; test thin, high, remarkable for the great size of the primary spines. Abactinal system delicate, and not prominent and stout as in other allied species.

The abactinal system resembles somewhat that of Temnopleurus Reynaudi. The madreporic genital is far greater than the other genital plates, which are pointed, pentagonal, narrow; three of the genital plates are separated by large pointed ocular plates which reach the anal system; the ocular plates are notched at the outer extremity, with a deep narrow furrow near the centre.

The poriferous zone is narrow; buccal membrane with a few small plates irregularly scattered over the surface. It is very probable that this species will eventually form the type of a new genus intermediate between Salmacis and Amblypneustes; unfortunately I have but a single specimen, and until there is more abundant material this species is temporarily placed with Amblypneustes, which is its nearest ally.

Diameter.	Height.	Abactinal System	Actinal System.	Spines.	No. of Coron. Plates.	Width Porif. Zone.
22.	21.2	4.8	7.8	7.	17.	1.2

Mauritius.

(AMBLYPNEUSTES.) HOLOPNEUSTES.

Holopneustes AGASS., 1841, Mon. Scut.

The ambulacra are broader than the interambulacra, owing to the extraordinary lateral development of the poriferous zone. Each zone is flanked by a regular vertical row of pores, the intermediate space is closely packed with pores arranged apparently irregularly, though in reality the irregularity is due only to an unusual lateral expansion of the central plate. General facies that of Amblypneustes. Lütken unites the genus with Amblypneustes. I cannot agree with him in this, as the true Amblypneustes, no matter how the pores are arranged, — in three vertical rows, as in Tripneustes, or trigeminate, — never have more than three regular vertical rows, so that I am inclined to consider this group as a subgenus of Amblypneustes. The actinostome is small, has no cuts. The spines and the abactinal system are essentially that of Amblypneustes. Teeth broad, with a low inner ridge. Spines short, moderately stout, longitudinally striated, and swollen at the extremity.

Holopneustes inflatus

! *Amblypneustes* **inflatus** LÜTK., 1872, in A. AG., Bull. M. C. Z., III.
! *Holopneustes inflatus* A. AG., 1872, Bull. M. C. Z., III.

Test moderately stout, nearly spherical; poriferous zone more than equalling in width the median ambulacral region, proportionally somewhat narrower than in H. porosissimus, the pores arranged in three well-marked vertical rows, — the inner and outer quite regular, the middle somewhat undulating and disconnected. One very regular vertical row of small secondaries

in the poriferous zone parallel with the inner vertical row of pores; others smaller, irregularly scattered, where the tubercles form irregular horizontal rows of from two to three tubercles for each plate. Towards the median space in both areas the plates carry small distant secondaries arranged in continuation of larger horizontal rows in the interambulacra, and irregularly placed in the ambulacra. In the interambulacral space there is for each plate a larger primary, forming a distinct vertical row, and from one to six smaller tubercles on each side of the median interambulacral line forming horizontal rows and very indistinct vertical rows. The tubercles between the principal primary vertical row and the poriferous zone are not as closely packed as in H. porosissimus. No bare median ambulacral or interambulacral spaces. The abactinal system is comparatively small, not prominent; anal system small. Madreporic genital somewhat larger than the other genitals. Ocular plates as in H. porosissimus, disconnected from the anal system, carrying few secondaries, as well as on the anal edge of the genital plates.

Color of test, denuded, yellowish-orange or reddish-orange, with the poriferous zone of a darker tint.

Diameter.	Height.	Actinal System.	Abactinal System.	Anal System.	Width Porif. Zone.	No. of Coron. Plates.
48.5	45.	12.	8.	3.4	4.5	46.
36.5	31.	10.	7.2	3.2	3.2	34.
34.	30.5	9.1	6.4	2.9	3.1	33.

New Holland.

Holopneustes porosissimus

! *Cidaris granulata* (**Agass.**), 1841, Mon. Scut.
! *Holopneustes* **porosissimus** Ag., 1846, C. R. Ann. Sc. Nat., VI.

Pl. VIII^c. f. 9–10.

Outline of test globular, test moderately stout. Poriferous zone broader than the median ambulacral space. Pores forming an outer very regular vertical row, an inner row somewhat undulating, while the remaining broad space is filled by apparently irregularly arranged pores, due to the great lateral spreading of the three original narrow plates of the poriferous zone in such a manner that the three pores belonging together form parallel rows, one shorter than the other either inwardly or outwardly, giving to the median space of the poriferous zone the aspect of being filled by irregular oblique lines of pairs of pores, between the inner and outer more regular

vertical rows. The tubercles of the interambulacral space form irregular horizontal lines, with rather large miliaries and secondaries closely filling the coronal plates, except a narrow, bare median band extending from the abactinal pole half-way to the actinostome, where the band disappears. There is one principal primary vertical row of large tubercles, between which and the poriferous zone the secondaries and miliaries are very closely packed. In the ambulacral space the tubercles are irregularly arranged, forming only most indistinct vertical rows; the tubercles are of more uniform size than in the interambulacral space, and a comparatively greater number as large as the primaries; the tubercles do not increase in size towards the actinostome, as in Amblypneustes. The spines are shorter, rather stouter, than those of Amblypneustes, and swelling at the extremity; they are coarsely striated longitudinally, the ridges forming small lamellæ at the swollen extremity; the shaft is very uniform in width, scarcely tapering towards the extremity. Milled ring very prominent. Abactinal system with narrow genital ring; genital plates of uniform size; large anal system; genital pores very large; ocular plates prominent, excluded from the anal system. Anal system and anal edge of the genital ring closely crowded by small tubercles, carrying small spines similar to those of the test. Secondary tubercles irregularly scattered over the whole poriferous zone.

The ground-color of the test is greenish-blue, with violet median lines in the ambulacral and interambulacral spaces; the tubercles are of a lighter color. The poriferous zone is light greenish with violet tinge. Spines greenish at base, with reddish tinge towards the tip.

Diameter.	Height.	Actinal System.	Abactinal System.	Anal System.	Width Porif. Zone.	No. of Coron. Plates.	Length of Spines.
49.	46.	10.8	9.2	5.	6.	48.	5.2

New Holland.

Holopneustes purpurescens

! *Amblypneustes* **purpurescens** LÜTK., 1872, in A. AG., Bull. M. C. Z., III.
! *Holopneustes purpurescens* A. AG., 1872, Bull. M. C. Z., III.

Pl. VI. f. 25–25ª; Pl. VIIIᶜ. f. 5–6.

Actinal and abactinal diameter equal, poriferous zone equal in width to the corresponding tuberculiferous ambulacral space. In large specimens the middle row of pores is very irregular, forming zigzag lines, while in younger specimens the middle row is nearly as uniform as the inner and outer rows;

the latter is characterized by the greater size of the inner pore, and the distance separating the pores of a pair. The tubercles of both areas form most regular horizontal rows, as many as ten tubercles of nearly uniform size, diminishing gradually towards the median line, and forming regular vertical lines towards the poriferous zone on each side of the median line in specimens of $80^{mm.}$ in diameter, and from one to three for the ambulacral spaces, forming no distinct vertical rows.

The test is thin, the poriferous zone being narrower than in the other species of the genus. The color of the small specimens, measuring $35^{mm.}$ in diameter, is a beautiful light violet, with greenish median bands both in the ambulacra and interambulacra and along the outer edge of the poriferous zone. In the large specimens the test is of a uniformly yellowish-brown color.

Specimens of Holopneustes are not common in museums, so that, with the exception of the variations observed in H. inflatus, it is difficult to know how far the species of the genus vary. The variations observed in H. inflatus and H. purpurescens are limited mainly to the poriferous zone in the young specimens, the three vertical rows of pores being at first quite distinct, then the middle row becomes undulating, and finally, with the lateral spreading the original arrangement is completely lost sight of. It may be that H. purpurescens will prove to be nothing but H. porosissimus with a rather narrower poriferous zone, the variations of the size of the pores recalling similar differences noticed in Toxopneustes pileolus. Additional material is needed to discriminate better the species of Holopneustes temporarily distinguished in the Museum Bulletin.

New Holland.

TRIPLECHINIDAE.

Subfamily **Triplechinidae** A. Agass., 1872, Rev. Ech., Pt. II.

PHYMOSOMA.

Cyphosoma (**Agass.**), 1840, Cat. Syst. Ectyp. (non Mann.).
Phymosoma Haime, 1853, D'Arch. et Haime, An. foss. Inde.

The teeth of this genus, representing a large number of fossil species of this and allied genera, of which there are now living but few representatives, do not present any striking features to distinguish them from the teeth of the Echinidae proper; they are not in the least allied to the teeth of Cidaridae and of Diadematidae.

The value of the presence or absence of crenulation of the primary tubercles as a generic character has been frequently discussed, and, owing to the difficulty of clearly distinguishing the presence of crenulation in fossil species, its value and importance have not been understood. As far as we can judge from the recent genera with crenulated tubercles, — Diadema, Phymosoma, Salmacis, Temnopleurus, and many genera of Spatangoids, — it is a feature which appears early and seems quite characteristic, but is frequently indistinct or obliterated. We can only guess at the function of this crenulation; it seems connected with the rapid and easy movements of the large or long spines attached to them, which require considerable muscular force and good points of support for the attachment of the muscular sheath at the base of the spines.

Phymosoma crenulare

! **Glyptocidaris crenularis** A. Ag., 1863, Proc. Acad. N. S. Phila.
! *Phymosoma crenulare* A. Ag., 1872, Rev. Ech., Pt. I. p. 151. [*Pl XXXVIII. f. 18, 19; Pl. VI. f. 2–3; Pl. VII^a. f. 6, 8, 9; Pl. XXV. f. 3–5; Pl. XXXVI. f. 10, 11;*

Test depressed, slightly pentagonal, flattened on the actinal side. Actinal opening moderate; actinal cuts slight. Actinostome covered by a thin membrane, thickly covered by elliptical plates, and their intervals filled by smaller elongated plates occupying the whole space. The median interambulacral and ambulacral spaces are bare from the abactinal system nearly to the ambitus. The two principal vertical rows of primary tubercles diminish

rapidly in size in both areas as they approach the apex. The coronal plates above the ambitus are sparsely covered by secondary tubercles. The smaller tubercles, arranged in an irregular circle round the main tubercles, are not crenulated, while the small secondaries, arranged on each side of the principal vertical rows in the interambulacral space, are crenulated. A vertical row of secondaries extends from the actinostome to slightly above the ambitus. In the ambulacral space there are only small uncrenulated secondary tubercles arranged irregularly round the primaries. In the abactinal system the genital ring is of uniform width, the madreporic genital being only slightly larger than the others. Two large ocular plates reach the anal system, which is covered by plates carrying a few tubercles; these plates diminish in size towards the eccentric anal opening. Tubercles of the abactinal system not crenulated, and principally confined to the anal edge of the abactinal plates.

The primary spines are long, stout, tapering gradually, with a fine longitudinal striation commencing at the milled ring. The color of dried specimens is yellowish, with darker-colored spines. The auricles are high, slight, with low connecting ridges. Teeth present no marked feature as distinguishing this type of Echini from the Echinidae proper.

No. of Interamb. Tub.	Diameter.	Height.	Abactinal System	Anal System.	Actinal System.	Length of Spines.
13.	46.	21.6	11.7	6.	17.2	32.

Japan.

(PSEUDODIADEMA.) Hemipedina.

Hemipedina Wright, 1855, Brit. Ool. Ech.
(See Part II. p. 291.)

Hemipedina cubensis

! **Caenopedina cubensis** A. Agass., 1869, Bull. M. C. Z., I.
! *Hemipedina cubensis* A. Agass., 1872, Rev. Ech., Pt. I. p. 132.
(See Part II. p. 291.)

Pl. III. f. 1–7; Pl. XXXVI. f. 12.

Straits of Florida.

ECHINUS.

Echinus RONDEL, 1554, De Piscib. (LINN). (emend.)
(See Part II. p. 293.)

Echinus acutus

! *Echinus* **acutus** LAMK., 1816, An. s. Vert.

Pl. VII^a. f. 5; Pl. XXV. f. 12–16.

The variation in the shape of the different species of Echinus is so great that any attempt to describe the general form and outline would be useless, and I shall confine myself to such special marks as are characteristic, and make the description as far as possible comparative. In E. acutus the general outline is slightly conical, and when seen from above somewhat pentagonal, the median interambulacral space being somewhat concave; with two principal vertical rows of primary tubercles, one for each plate; the rest of the plate sparsely covered by secondary tubercles, forming an irregular arc above the primary. Nearer the actinostome there are two other vertical rows, but they do not extend much beyond the equator on each side of the primary towards the abactinal pole. Coronal plates high. Median interambulacral as well as ambulacral space bare. In the ambulacral space two principal vertical rows of primary tubercles near the poriferous zone, with two additional irregular ones extending from the equator towards the actinostome. Auricles broad. Anal system moderate. Genital plates pointed, carrying generally three small secondary tubercles near the anal edge; genital opening near the exterior edge of the plate; ocular plates pentagonal, openings distinct. Primary spines stout, tapering, usually of a darker color than the test, brilliant carmine at base, tapering to white or greenish tips, finely striated. This is known to Italian zoölogists as E. sardicus.

Norway; Mediterranean.

Echinus angulosus

! *Cidaris* **angulosa** LESKE, 1778, KL. Add.
! *Echinus angulosus*, A. AG., 1872, Rev. Ech., Pt. I. p. 122.

Pl. VII^a. f. 3.

The longer, more slender spines, — generally tipped with violet, the shafts of all shades between that and the lightest yellow, — the thinner test, the

greater number of coronal plates, and structure of abactinal system, at once separate this from E. miliaris. We have in the median interambulacral space one principal vertical row of tubercles, but they are as small as the secondaries in E. miliaris; in the remainder of the plate they are arranged irregularly, forming neither vertical nor horizontal lines, more closely packed between the main row and the poriferous zone; towards the median line the secondaries and miliaries occupying the coronal plate are most numerous. The arrangement is the same in the ambulacral space; the median vertical rows are composed of small secondaries scarcely larger than those forming the vertical line in the poriferous zone. The poriferous zone is much broader than in E. miliaris, and there are from one to three indistinct vertical rows of tubercles formed from the small secondaries.

The differences in the anal systems of the two species are marked, the genital ring is narrow, and frequently two of the ocular plates reach the anal system, which is comparatively much larger than in E. miliaris; the ocular plates are also larger. The secondaries on the genital plates near the anal edge are small, and the anal plates are but little tuberculated; both in miliaris and in this species there are three to four very much larger anal plates, — the rest are small, diminishing in size towards the anal opening; actinal cuts more marked than in miliaris.

The buccal membrane is thin, and is but sparsely covered by limestone plates, which, in this species and in Magellanicus, are reduced almost to a minimum; although E. angulosus belongs strictly to Psammechinus, the plates are not even as numerous as we find them in Echinus proper. This shows that the features upon which these two genera have been separated are not tenable. In fact, when we examine young E. esculentus, it would puzzle us to know whether to place them in Psammechinus, on account of their close uniform tuberculation, or in Echinus, on account of their smooth actinal membranes.

No. of Tubercles.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Width Porif. Zone.	Spines.
19.	34.9	16.2	7.6	4.	12.6	2.2	7.8
19.	38.	22.3	7.5	3.7	14.4	2.2	10.5
24.	58.2	28.	10.2	4.9	17.7	3.5	13.
22.	52.4	28.8	10.4	4.5	17.3	3.2	16.9

Cape of Good Hope; Mauritius; Red Sea; Philippine Islands; New Zealand.

Echinus elegans

! *Echinus elegans* (**Düb. o. Kor.**), 1844, Skand. Ech.

Pl. VII^a. f. 4.

Recognized from its congeners by the beautiful vermilion bands, extending from the apex towards the ambitus on both sides of the bare median vertical line, both in the ambulacral and interambulacral spaces, separated by the broad, yellowish poriferous bands. The principal rows of rather small primary tubercles stand out in bold relief from the plates, which carry fiom five to six secondary tubercles in the interambulacral, and are crowded by miliaries, especially near the ambitus; in the ambulacral the miliaries are as numerous, but there are only one to two secondaries. The test is thin; the genital plates are large; edge near the anal system closely covered by miliaries and secondaries. The primary spines are long, slender, often brilliantly colored, red, green, or tipped with white, green at base, or pink at the extremity. The secondaries are sometimes the color of the primaries, but more usually of a uniform tint. In very large specimens alternate primary tubercles in both areas of the main vertical row are frequently resorbed.

Norway; Mediterranean.

Echinus esculentus

Echinus **subglobosus** Linn. 1745, Fauna Suec.

Echinus esculentus Linn. 1758, Syst. Nat.

Pl. VII^a. f. 7.

The coronal plates are broad, thinly covered by miliaries, covered with tubercles nearly uniform in size, slightly smaller towards the median line, with a large well-defined scrobicular and small but sharply defined tubercle arranged in irregular horizontal lines. The poriferous zone is broad. The median ambulacral space is about twice as broad as the poriferous zone; the edge nearest the poriferous zone is flanked by a closely crowded vertical row of primary tubercles as large as any of the median interambulacral region; the rest of the plate is covered by tubercles and miliaries arranged as in the interambulacral zone. The genital plates are heptagonal; madreporic genital much larger than the others, covered with large secondary tubercles like those of the test; ocular plates well separated from the anal system by the genital plates. Actinal membrane with plates irregularly scattered in the continuation of the ambulacral system. The spines are short,

rather stout, varying in color from white almost to purple. Color of test brick-red, or brownish and intermediate shades, with scrobicular circle set off in light upon this.

Norway; English Channel.

Echinus gracilis

! *Echinus* **gracilis** A. Ag., 1869, Bull. M. C. Z., I.

(See Part II. p. 293.)

Pl. VI^a. f. 6; Pl. VII. f. 1–6.

Straits of Florida; St. Thomas.

Echinus magellanicus

! *Echinus* **magellanicus** Phil., 1857, Wieg. Arch., I.

Only small specimens of this species exist thus far in the Museum, unless an Echinus of which Mr. H. Edwards sent a couple of tests from Australia, should prove the adult of it; as, unfortunately, they do not come from New Zealand, where E. Magellanicus is found, I have made the description from the smaller specimens, awaiting further materials. The small specimens recall in general aspect the Mediterranean E. microtuberculatus. Abactinal system is very prominent; test thin; poriferous zone distinctly colored, giving the dry test a banded appearance. There are only two principal prominent rows of tubercles in the interambulacral space; generally but one ocular plate reaches the anal system, frequently all are excluded; genital plates thickly tuberculated near the anal ring with small secondaries; poriferous zone very narrow. Coronal plates narrow, closely packed with irregularly arranged small secondaries and miliaries, tending to form irregular vertical lines in the median ambulacral spaces; spines fine, moderately long; actinal membrane smooth, nearly bare; but few actinal limestone plates. Color of the test light violet; edge of poriferous zone white; spines violet, tipped with yellow. In younger specimens a regular ornamentation is formed by the miliaries arranged round the secondaries. The actinostome is remarkably small, nearly round, with the slightest possible notches.

No. of Tubercles.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Spines.
18.	28.	13.8	8.	8.9		
15.	24.7	12.	8.	8 8	4.	
13.	15.	8.	5.	7.7	2.5	4.1

Patagonia; Chili; New Zealand.

Echinus margaritaceus

! *Echinus* **margaritaceus** LAMK., 1816, An. s. Vert.

As suggested by Lütken, this is a true Echinus in the restricted sense (Desor, emend.), with very marked features. It is flattened, slightly conical, resembling in outline E. elegans; has, like E. norvegicus, a large anal system, but, unlike either elegans or norvegicus, the genital plates are narrow, with three small tubercles near the anal edge; the genital openings large. The coronal plates are not high; the principal row of vertical interambulacral tubercles is small; the remainder of the plate is densely covered with minute secondary tubercles carrying short, slender, yellowish spines closely crowded together, which are a lower groundwork from which the primary spines, long, slender, and white, project prominently. The rest of the space of the plates is closely covered by miliaries, covering the whole test with its huge pedicellariæ, except the indistinct vertical median line, both in the interambulacral and ambulacral region, which extends to the ambitus from the pole. The mamelon of the tubercles is large, the boss very prominent and well defined. The ambulacral area is broad, the principal tubercles of the main vertical row but slightly smaller than those of the interambulacral space, the secondaries covering equally closely the whole plate.

Patagonia.

Echinus melo

! *Echinus* **melo** LAMK., 1816, An. s. Vert.

Almost globular, very ventricose. Actinal opening much smaller than in E. acutus. Smaller, thinner, and less powerful auricles. Coronal plates very elongate, so that, when specimens of the same size are compared to E. acutus, we can at once discriminate them by the greenish-yellow tinge of the test, while in acutus red and pink tints are most common. The principal row of vertical primary tubercles is small; the rest of the plate is more fully packed with secondaries than is the case in acutus, and densely covered with miliaries carrying globicephalous pedicellariæ. Alternate primary tubercles are frequently absent in both acutus and melo; the horizontal sutures are bare both in the ambulacral and interambulacral area, forming a lozenge-shaped pattern of a lighter color than the main color of the test. This feature is usually not so prominent in acutus, and frequently totally wanting. In large specimens the secondary tubercles form six or seven vertical rows of tubercles hardly extending beyond the ambitus.

The primary spines are sharper, more slender, shorter, and are much more closely striated than in acutus, of a greenish tinge, usually slightly darker at the base. The abactinal system closely resembles that of acutus. The genital openings are not so near the edge of the plates, and there are from five to seven small tubercles near the anal edge, with the rest of genital plates frequently well covered by miliaries, while in acutus there are coarser secondaries and a much smaller number of miliaries. The median vertical sutures of the ambulacral and interambulacral space form a plainly marked zigzag line, usually double, diminishing in breadth towards either pole.

Mediterranean.

Echinus microtuberculatus

! *Echinus* **microtuberculatus** Blainv., 1825, Dict. Sc. Nat. O.

Pl. VI. f. 4; Pl. VII^a. f. 1–2; Pl. VIII. f. 19–21.

A great deal of the confusion concerning the identity of the Mediterranean species arises from the fact that their northern representatives are found associated with them; as, for instance, E. miliaris and E. microtuberculatus, E. acutus and E. melo, E. cordatus and E. mediterraneum; and, also, that sometimes where no difference exists, — B. lyrifer = B. pulvinatus; C. papillata = C. hystrix, — the same species frequently appears under a different specific name if found in the Mediterranean from that it receives when coming from the Atlantic and the Northern Ocean. In many of the museum collections I have examined, E. miliaris and E. microtuberculatus are not distinguished when the localities are not marked otherwise than as Mediterranean. Yet the two species are remarkably distinct; it is not the young of E. melo, as has been suggested, but a Psammechinus in the old sense, with strongly imbricated buccal membrane. The actinal opening is very small, circular, with the slightest possible cuts. The poriferous zone is narrow, the pores being arranged almost vertically, with but a slight obliquity, forming three pairs. The test is thin, flattened; the abactinal system large, prominent, with a very large anal system, covered by small plates of uniform size, slightly tuberculated; the genital ring is comparatively narrow; genital and ocular plates covered by small secondary tubercles, nearly of uniform size; madreporic body but slightly larger than other genital plates; ocular plates excluded from the anal system; genital openings large. Two principal vertical rows of large tubercles in the ambulacral and interambulacral space; rest of coronal plates filled with closely arranged

secondary tubercles, forming neither horizontal nor vertical rows, arranged irregularly, the spaces closely filled with miliaries. The plates of the poriferous zone are high, shagreened with miliary granulation; pores far apart, distant vertically. Spines are fine, short, thin, generally colored greenish, with white or yellowish tips; the actinal plates are irregular in outline, forming a perfect closely packed limestone pavement over the buccal membrane.

No. of Tubercles.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Width Porif. Zone.	Spines.
14.	29.4	15.	8.3	5.1	9.7	1.6	5.
12.	14.5	9.	4.2	1.9	6.	0.9	3.8

Mediterranean; Cape Verde Islands.

Echinus miliaris

! *Echinus* **miliaris** MÜLL., 1771, KNORR, Delic.

Pl. XXV. f. 11.

This the best known species can be taken as standard for comparison. The outline is more or less pentagonal according to age; the test is thick, flattened below, slightly conical above; in younger specimens the outline is more regular, and regularly arched. The median interambulacral spaces are closely packed with tubercles of nearly uniform size, one tubercle for each plate, forming the two principal vertical rows of tubercles, being slightly larger; the other tubercles are arranged in two parallel irregular rows exterior to the poriferous zone, tapering to the apex, and one horizontal row in the centre of plate, towards the median line; the rest of the plate is filled by parallel horizontal rows of minute secondaries, with uniform miliaries. The median interambulacral line is slightly depressed in old specimens. The ambulacral space has two exterior larger and two interior smaller vertical rows of tubercles of about the size of the second size of tubercles in the interambulacral space; groups of small secondaries in the poriferous zone form an irregular vertical line adjoining the large row of tubercles.

Abactinal system large, compact; ocular plates small, all excluded from the anal system; madreporic body not greatly larger than the other plates. Secondary tubercles on the anal edge of genital plates; anal plates few in number, smooth. Buccal membrane strongly imbricated, formed of long narrow limestone plates, closely packed together. Actinal system of moderate size; cuts slight. Spines short, moderately slender, of a greenish tinge, with pink, grayish, or whitish tips.

In younger specimens the contrast between the two principal rows of the secondaries is more marked, the space between the latter is greater; a close miliary granulation covers the high coronal plates.

No of Tubercles.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Width Porif. Zone.	Spines.
13.	20.	11.8	6.8	9.	2.8	1.6	6.
16.	36.2	19.9	9.5	14.9	3.2	2.	8.9
18.	38.	19.	8.2	13.9	3.1	2.6	8.
19.	45.5	27.6	10.2	17.8	4.9	3.	11.

Norway; English Channel.

Echinus norvegicus

! *Echinus* **norvegicus** DÜB. o. KOR., 1844, Skand. Ech.

(See Part II. p. 296.)

Pl. VI^a. f. 4.

Norway; Mediterranean; Straits of Florida.

TOXOPNEUSTES.

Toxopneustes AGASS., 1841, Int. Monog. Scut.* (non AG., 1841, An. Ech., nec 1846, C. R.)

(See Part II. p. 297.)

Toxopneustes maculatus

! *Echinus* **maculatus** LAMK., 1816, An. s. Vert.

! *Toxopneustes maculatus* A. AG., 1872, Rev. Ech., Pt. I. p. 167.

There are but few specimens of this species in the different Museums, nearly all of the same size, and all unfortunately devoid of spines and of actinal membrane. The very peculiar pattern of coloration of the denuded test, the large, irregular, star-shaped violet blotch round the abactinal pole, extending some way down the test, and the broad band of the same color round the ambitus, give the test a very remarkable aspect; but in spite of this, and of its more regularly arched outline, the general measurements agree very well with T. pileolus. As long as we know nothing more definite regarding the anal and actinal system, it is as well to point out here the differences just mentioned, and add that the arrangement of the tubercles is somewhat different; they are farther apart than in any specimens of T. pileolus I have had occasion to examine. The outline from above is very regular, and the most prominent feature is the comparatively shorter

* Not as on p. 297, **Toxopneustes** AGASS., 1836, Prod.

size of the actinal cuts and of the projecting lips of the interambulacral part of the cuts. This species is figured by Valenciennes in the *Atlas du Voyage de la Vénus*, but the lips are somewhat exaggerated and are not so prominent in the original.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Width Porif. Zone.
26.	81.	31.		27.5		3.2
28.	80.5	37.	11.	28.	5.3	4.1

Christmas Island; Bourbon.

Toxopneustes pileolus
! *Echinus* **pileolus** LAM., 1816, An. s. Vert.
! **Toxopneustes** *pileolus* AGASS., 1841, Monog. Scut. Int.

Pl. VIII^b. f. 1–2; Pl. XXV. f. 20, 21; Pl. XXXVIII. f. 16, 17.

The differences formerly considered as specific between the species of this genus do not hold when a large series of specimens is examined. The variations found in specimens from different localities and of various sizes are very considerable, extending to the breadth of the poriferous zone, the size of the pores, the proportions of the actinostome, the concavity of the actinal surface, and the greater or less conical outline of the test.

In young specimens of Toxopneustes the arrangement of the pores is in arcs of three pairs; the actinostome is not sunken; the cuts are slight; the secondary and primary tubercles are arranged somewhat irregularly upon the plates both of the ambulacral and interambulacral regions, forming only two regular vertical rows in each area. The test of young specimens is usually ornamented with spirally arranged bands of color, extending across the ambulacral and interambulacral areas in disconnected patches, the bands growing narrower towards the abactinal pole (B. bizonata, DES.). With increasing age these bands become more and more indistinct, and can often be but faintly traced in the largest specimens examined. In larger specimens the arrangement of the pores is in three apparently independent vertical rows; the size of the pores of the same specimen varies greatly in the different ambulacra, and even in the different vertical rows of the same poriferous zone, either the inner or the outer row having the exterior pore the largest (B. heteropora, DES.). In what has been considered usually the typical T. pileolus the arrangement of the pores is uniform, preserving more persistently the original arrangement of the pores, though the two outer

vertical rows of pores are placed slightly closer together, and separated from the inner row. In specimens where there are at the ambitus twelve vertical rows of tubercles in the interambulacral space, there are eight in the ambulacral region. Only one vertical row on each side of these regions extends to the abactinal system; the others extend some ways above the ambitus, leaving a small part of both the median areas bare, in proportion to the development of the vertical rows. The miliaries and secondaries are arranged in horizontal rows across and between the primary vertical rows, forming a simple network round the scrobicular circle of the primaries.

The abactinal system is compact; the madreporic genital very prominent; the genital openings large near the apex of the plates; the genital and ocular plates carry one large tubercle, with secondaries and miliaries arranged round the scrobicular circle as round the primaries of test. The anal plates are small, smooth, oblong, with a few larger triangular ones on the side opposite the anus. The spines above the ambitus are short, moderately stout; those of the lower side, however, are much longer and more slender. The outline of test from above is pentagonal, with re-entering angle in the median interambulacral space; the ambulacra projecting beyond the general outline of the test. In profile the outline is generally somewhat conical, though young specimens are more regularly arched, and, when quite small, almost globular; in older, fully grown specimens the shape is sometimes quite globular. The actinostome is more or less sunken, and the lower surface concave; in medium-sized and large specimens the depth of the actinal cuts varies considerably.

The extensive series of specimens of this species in the Jardin des Plantes, and a number of specimens from Mauritius in the Museum Collection, show such variations that I am unable in the adult to distinguish as distinct species what I had called Boletia rosea from Central America, and the common Indo-Pacific, B. pileolus. Though, if what Mr. Verrill has called Psammechinus pictus should turn out to be the young of B. rosea (B. picta), as he is inclined now to consider it, it would be quite easy to separate these two species when young by an examination of the buccal membrane, which is stoutly imbricated in P. pictus, while the actinal membrane of young specimens of B. pileolus, of the same size, is particularly bare and free from limestone plates, except in the vicinity of the two large buccal plates.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Actinal System.	Anal System.	Width Porif. Zone.	
25.	71.	31.	10.5	22.	5.3	3.4	From Acapulco.
31.	101.	39.	14.2	33.	6.9	5.1	
16.	19.8	11.4	5.	9.	2.1	1.1	From Mauritius.
24.	60.	36.	9.9	33.9	4.3	3.2	
32.	105.	46.	14.8	35.	5.9	6.1	
34.	103.	48.	14.3	34.5	6.	4.2	
	128.			38.		6.2	

Panama; Feejee Islands; Mauritius; East India Islands.

Toxopneustes semituberculatus

! *Echinus* **semituberculatus** VAL., 1846, in AG. DES. C. R. Ann. Sc. Nat., VI.
! *Toxopneustes semituberculatus* A. AG., 1872, Rev. Ech., Pt. I. p. 168.

The principal characters which at once distinguish this species from its West Indian representative (T. variegatus) are the comparatively much larger actinostome, the large coarse granulation occupying nearly the whole of the bare median interambulacral and ambulacral spaces, and the comparatively small size of the primary tubercles, as the larger number of coronal plates in specimens of the two species of the same size readily shows. In the abactinal system the genital openings are close to the apex, at the very tip of the genital plates, indenting the extremity of the genital plate itself. The actinal cuts are broader, and the abactinal system larger than in T. variegatus. In dried specimens the color of the test is of an olive-green, with brighter bands along the poriferous zone. The buccal membrane is plated, but not so thickly packed as in T. variegatus. The spines are comparatively shorter and more slender, of the general color of the test, only somewhat darker.

No. of Coron. Plates.	Diameter.	Height.	Actinal System.	Abactinal System.
21.	32.	18.	15.	
23.	39.	22.	17.5	
27.	46.5	24.	20.	9.

Galapagos; Central Pacific America; Cape St. Lucas.

Verrill has described as Psammechinus pictus a young sea-urchin which I had, from analogy with the corresponding stages of Toxopneustes variegatus, referred to this species. Mr. Verrill subsequently considered it to be the young of (Boletia picta) Boletia rosea. I am still inclined, from want of better proofs, to retain my view of the affinities of this small Echinus, especially since I have had occasion to compare it with the young of Boletia pileolus from the Sandwich Islands. The structure of the buccal membrane of Psammechinus pictus seems, as far as we know anything of the young stages of

Boletia pileolus, to point to its identity with T. semituberculatus rather than to its affinity to (B. rosea) T. pileolus, the young of which has a nearly bare buccal membrane. The material for a definite conclusion is not in our collections, and no positive results can be reached at present.

Toxopneustes variegatus

! *Echinus variegatus* (**Lamk.**), 1816, An. s. Vert.
! *Toxopneustes variegatus* A. Ag., 1872, Rev. Ech., Pt. I. p. 168.
(See Part II. p. 298.)

Pl. II. f. 5–6; Pl. IV^a. f. 4–5; Pl. VI. f. 23; Pl. VII. f. 7–22; Pl. XXV. f. 17–19.

Brazil; West India Islands; Bermudas; South Carolina.

HIPPONOË.

Hipponoë Gray, 1840, Synops. Cont. Brit. Mus.
(See Part II. p. 301.)

Hipponoë depressa

! *Tripneustes* **depressus** A. Ag., 1863, Bull. M. C. Z. I.
! *Hipponoë depressa* A. Ag., 1872, Rev. Ech., Pt. I. p. 134.

The differences between the two species of Hipponoë found on the Atlantic and Pacific sides of the Isthmus of Panama are slight, but well marked. They consist, in the Pacific species, in the comparatively higher coronal plates, the irregular arrangement of the primary tubercles, not forming, as in the West India species, regular vertical rows as well as horizontal ones. There is only one well-defined vertical row of primaries, somewhat nearer the poriferous zone than to the median line in the interambulacral space. The anal system and the actinostome are comparatively smaller in the West India species, in which the buccal membrane is nearly smooth, while it is thickly covered by large plates at its junction with the test in the Pacific species.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Width Porif. Zone.	Spines.
40.	127.	62.	16.8	9.	29.	9.8	14.
	118.	71.					

Gulf of California.

Hipponoë esculenta

! *Cidaris esculenta* (Leske), 1778, Kl. Add.
! *Hipponoë esculenta* A. Ag., 1872, Rev. Ech., Pt. I. p. 135.
(See Part II. p. 301.)

Pl. VI. f. 28–29; Pl. VI^a. f. 1–3; Pl. VIII. f. 29.

Florida; West Indies; Surinam.

Hipponoë variegata

! *Cidaris* variegata Leske, 1778, Kl. Add.
! *Hipponoë variegata* A. Ag., 1872, Rev. Ech., Pt. I. p. 135.

Pl. IV^b. f. 5–6; Pl. XXV. f. 6–7.

As the Synonymy shows, this is one of the most variable of the species of Echini in general appearance and in outline. Some specimens are nearly globular, others greatly depressed, others with a pentagonal outline from above, and re-entering median interambulacra near the ambitus; the outline in profile varying from depressed to globular or conical. The general appearance of this widely distributed species is such as readily to separate it from the American species of the same genus. In the first place, the small size of the tubercles and their smaller number are eminently characteristic of this species. The median ambulacral and interambulacral spaces are generally bare from the abactinal pole to the ambitus, being covered by a few small miliaries far apart. The anal system is comparatively very large; the abactinal system is more circular, less pentagonal, owing to the smaller size of the genital plates, than in the West India species. The poriferous zone is also much narrower; the actinostome larger; the spines much more slender. The coloring of the specimens is best shown by the names of some of its synonymes, — violaceus, subcoeruleus, nigricans, — showing the range of coloration; the pentagonal specimens (pentagonus) having a more brownish yellow coloration, much as in the West India specimens. The buccal membrane is scarcely covered by calcareous plates; the plates of the anal system are smaller and more numerous than in the West India species.

No. of Coron. Plates.	Diameter.	Height.	Abactinal System.	Anal System.	Actinal System.	Width Porif. Zone.	Spine.
37.	54.	101.2	15.8	9.2	24.5	7.	13.
	72.	108.					
	45.5	74.					
	53.	79.					
27.	36.5	60.	13.	6.8	20.	5.8	12.
24.	22.	40.	7.	4.2	14.9	3.2	7.

Sandwich Islands; Japan; East India Islands; Feejee Islands; Red Sea; Mozambique.

(HIPPONOË.) EVECHINUS.

Evechinus VERRILL, 1871, Notes on Radiata.

This genus is closely allied to Hipponoë, having, when covered with spines, its general facies; the test is thick, circular, somewhat flattened, and covered with tubercles of very unequal size; the primaries arranged in regular vertical rows; the secondaries irregularly grouped round the base of primaries. Poriferous zone broad; pores arranged in three irregular vertical rows, narrowing towards the actinostome. Actinostome small; cuts slight; buccal membrane thin, carrying few plates. Abactinal system prominent; genital ring narrow; anal system moderate. Spines stout, tapering, rather short, very unequal in size. The close arrangement of the secondaries between the primaries recalls (Psammechinus) Echinus. The poriferous zone of the adult is like that of Hipponoë, while in the young it is like the zone of Echinus, and in other stages the irregular arrangement of the pores recall some of the species of Heliocidaris, as the genus was constituted in the Catalogue Raisonné.

Evechinus chloroticus

! *Echinus* **chloroticus** VAL., 1846, Voyage Vénus.
! **Evechinus** *chloroticus* VERRILL, 1871, Notes on Radiata.

Pl. IV^b. f. 7; Pl. VI. f. 30.

Test moderately thick; outline from above nearly circular, slightly depressed. Actinal region somewhat sunken, in profile regularly arched. Two principal vertical rows of ambulacral tubercles, with an irregular median row of smaller ones extending from the abactinal to the actinal pole. The ambulacral and interambulacral plates are closely crowded by secondary tubercles arranged in circles round the primaries; miliaries in plates of both areas few in number. There are six principal vertical rows in the interambulacral region; near the ambitus the exterior rows become somewhat irregular; along the median interambulacral line an irregular or vertical row of smaller tubercles. The poriferous zones are wide, narrowing at the actinal region. The vertical rows of pores are separated by two rows of secondary tubercles, the inner row consisting of the larger tubercles.

The anal system is small, covered by an outer ring of from nine to eleven plates of uniform size; the rest of the anal system is filled with small plates

converging towards the anal opening. Madreporic genital far larger than the other genital plates; genital openings large, near the outer edge. Genital plates carry one large secondary tubercle near the anal system; smaller ones fill the rest of plate. Ocular plates small; the two reaching the anal system carry secondary tubercles. Actinal cuts slight; buccal membrane thin, covered by very small distant plates, and a few well-separated clusters of from six to eight larger plates in the extension of the ambulacra. Spines rather stout, light green tipped with yellow; color of the test greenish-brown. In smaller specimens measuring not more than one fifth the above-described specimen, — $18^{mm.}$ in diameter and $17^{mm.}$ in height, with fourteen coronal plates, — the poriferous zones are narrow in proportion to the size of the test, we find only one row of pores separated by a vertical line of secondary tubercles from the outer rows of pores, which consist of two pairs of pores placed obliquely near the ambitus, while near the abactinal region the poriferous zone has all the features of (Psammechinus) Echinus; the changes in the arrangement of the poriferous zone at different stages of growth will account for the position of this genus in so many different genera by various authors. In the young the two principal vertical rows of tubercles are more prominent than in older stages.

No. of Coronal Plates	Diameter.	Height.	Abactinal System.	Actinal System.	Length of Spine.
25.	107.	62.	14.	24.	28.

New Zealand.

CLYPEASTRIDAE.

Suborder **Clypeastridae** AGASS., 1836, Prod. Mon. Rad.

The suborder of Clypeastridae has been recognized much within the same limits as first established by Agassiz. I am fully aware that the tendency of all recent writers on Echini has been to adopt, as most natural to the present condition of our knowledge, the division into two suborders, as proposed by Albin Gras. As I have already shown in my Embryology of the Star-fish, and from the more recent study of young Echini in the preliminary Report of the Deep-Sea Florida Echini, the separation of the anal opening from the apical system is not alone sufficient ground to separate the Echini into two suborders of equal value.

We have among the Clypeastroids, as they are here understood, structural features and combinations such as are not known in any other group of Echini, and which prevent us from associating with either of the usually recognized suborders those sea-urchins in which we find the upper and lower floors, the actinal and abactinal surfaces, connected by limestone walls, pillars, or radiating partitions. The suborder is strictly intermediate between the Desmosticha and Petalosticha, having the petaloid structure of the ambulacra and anal opening disconnected from the apical system, giving us, as in the latter, the position of an anterior and posterior extremity, and the jaws of the former, though simpler and greatly modified, and moved by a totally different mechanism, articulating upon the auricles instead of being held in place by a muscular system as in the regular Echini. They are V-shaped, placed horizontally, and in a groove corresponding to the line of junction of the two ossicula are placed the teeth. The structure of the spines is more similar to that of the regular Echini. The ambulacral pores of the petals pass between the plates; the ambulacral system is greatly developed, lines of minute pores extend at right angles to the general course of the poriferous zone. On the actinal surface there are ambulacral furrows crowded with pores arranged without any regular order; the furrows terminate at the actinostome in the buccal tubes; in some of the families the plates round the actinostome are cuneiform, forming a buccal rosette. The ambulacra are broader than the interambulacra; in many of the Laganoids the interambulacra are reduced to a narrow band. Tubercles small, perforate, and crenulate.

EUCLYPEASTRIDAE.

Family **Euclypeastridae** HAECKEL, 1866, Generelle Morphol.

In the Monographie des Scutelles the first attempt was made by Professor Agassiz to separate the Clypeastroids into natural groups, based upon their internal structure. Desor subsequently adopted, in his Synopsis, the subdivisions suggested by Agassiz; these subdivisions, as far as we have studied them, appear natural, and have been adopted, with the exception that the subfamily of Fibularina of Gray has been retained, and has been separated from the Laganidae, with which they had been associated by Agassiz and Desor.

This family contains Echini, with simple supports connecting the upper and lower floors, either as pillars, walls, needles, or radiating partitions, and of which the test is covered by spines of a uniform structure, the mode of formation of the internal supports forming the principal basis for the distinction of subfamilies.

FIBULARINA.

Subfamily **Fibularina** GRAY, 1855, Cat. Rec. Echini. (emend.)

This subfamily contains small globular Echini, with rudimentary petals, high teeth, and simple partitions radiating, extending from the periphery towards the actinostome.

ECHINOCYAMUS.

Echinocyamus VAN PHEL., 1774, Brief.
(See Part II. p. 304.)

Echinocyamus pusillus
Spatagus pusillus MÜLL., 1776, Prod. Zoöl. Dan.
! *Echinocyamus pusillus* GRAY, 1825, Ann. Phil., p. 6.
(See Part II. p. 304.)

Pl. XI^e. f. 3; Pl. XIII. f. 1–8.

Norway; Mediterranean; Azores; Florida.

FIBULARIA.

Fibularia LAMK., 1816, An. s. Vert.

The characters of this genus must remain doubtful, so long as we have no positive evidence that the small species of which it is composed are not the young, either of some species of Echinocyamus or of some species of Cassiduloids. It contains small species more or less ovoid or flattened, distinguished from Echinocyamus by the absence of distinct anterior peripheric radiating partitions; there are highly developed auricles, and we find near the anus, on the lower floor, traces of the radiating partitions of Echinocyamus; anus infra-marginal. Petals imperfectly petaloid; diverging pores distinct, not conjugated, or only indistinctly, few in number; petals remaining rudimentary, as in young Clypeastroids, and not closing at any time; poriferous zones extending from the apex to the actinostome as disconnected pores. The jaws are very small, high, resembling in their general structure the jaws of the Echinanthidae, and not of the Scutellidae; they are intermediate in their general features between the jaws of Laganidae and of Echinanthidae. Actinostome central; anus nearer the actinostome than the ambitus.

Fibularia australis
Fibularia **australis** DESML., 1837, Syn. p. 240.

Pl. XIII. f. 9–10.

This is the largest species of Fibularia known. Specimens measuring about $20^{mm.}$, longitudinal diameter, (16^{mm} transverse,) resemble in general outline small specimens of Clypeaster. The test seen from above is elliptical, slightly broadest anteriorly, regularly arched, with rounded edge from the edge of the test to the apex, which is central; outline sloping somewhat towards the posterior edge. Petals open at the extremity, diverging from the apex towards the edge of the test; pores not conjugated; four genital openings; petals extend nearly to the edge, the posterior pair somewhat shorter; poriferous zones equal, narrow, but slightly petaloid; pores distant, round. Mouth large, pentagonal, placed somewhat nearer the posterior edge; anus elliptical, irregularly transverse, very large, occupying a third of the space between the mouth and the posterior edge. Mouth sunken, and the whole median posterior part of the lower side concave, while the anterior and edges are rounded and swollen. Tuberculation of the abactinal part of the test

large, distant; intermediate space packed by minute miliaries on the lower surface; the tubercles become more distant towards the actinostome, which is surrounded by five smooth bands, formed of very minute tubercles, much as in the bourrelets and their prolongation in the Cassiduloids.

In smaller specimens not measuring more than $8^{mm.}$ in longitudinal diameter ($6^{mm.}$ transverse), the proportionally shorter open petals and more pointed posterior edge are the only differences noticed. Auricles nearly as prominent as in Echinocyamus; jaws compact, high, like the jaws of Echinocyamus. There are no additional pillars between the two floors, developed with age, as the presence in the young of anal posterior ridges on the two sides of the anal opening connecting the upper and lower floors would lead us to suppose. They are the homologue of the radiating partitions of Echinocyamus, but neither do they extend to the mouth, nor are additional walls formed, as in that genus. The smallest specimens examined did not measure more than $2^{mm.}$, longitudinal diameter; they differed from older specimens by their more regularly arched abactinal surface, and the small size of the anal opening; its position was identical with that of older stages; the number of disconnected pores (three and four pairs) forming the rudimentary petals is small; they only diverge a short distance from the apical system.

This species was originally placed in Echinocyamus; the internal differences are, however, sufficient to separate it from Echinocyamus proper, viz. the absence of the anterior and interior radiating partitions. Gray separated this species as an independent genus (Mortonia). I have removed it from Echinocyamus to Fibularia, with which, from the absence of lateral radiating partitions, it seems most closely allied, but I am by no means satisfied that the genus Echinocyamus and Fibularia are properly distinguished, and that future study among these small Echini, with better material, will not modify the views of their affinities here suggested.

Sandwich Islands; Japan; Australia.

Fibularia ovulum

Echinus **minutus** PALL., 1774, Spic. Zoöl., IX. *Pl. I. f. 3a.*

! **Fibularia** *ovulum* LAMK., 1816, An. s. Vert., p. 17.

Pl. XIII^{e}. f. 1–3.

This is the most common species of Fibularia in our collections, known and quoted under a multitude of names, from the figures of Van Phelsum, yet

it has not been examined critically with a view to determining its affinities; most of the specimens usually preserved have lost their spines, as well as the anal and buccal membranes. The genus is retained among the Clypeastroids from its close affinity to Echinocyamus. The presence of teeth and of partial rudimentary partitions only shows that the genus is an anomalous one, and its exact position either with the Clypeastroids or Cassiduloids cannot be accurately determined until we are better acquainted with the anatomy of Fibularia than we are at present, as there are as many reasons for associating them with the one group as with the other; and until we can be sure that neither Fibularia volva nor F. ovulum are not young stages the question must remain unanswered.

The test is ovoid, angular, pointed anteriorly, high; abactinal surface regularly arched; petals short; pores diverging, distant, not conjugate; poriferous zones consisting of not more than six or seven pairs of pores in specimens measuring 10^{mm}, longitudinal diameter. Middle of interambulacral plates raised, forming ridges running from the apex to the actinostome, especially well developed in the anterior part of the test. Apical system central; vertex anterior, at the extremity of the odd petal; test sloping, uniformly arched towards the posterior edge; petaliferous part of test flattened. Lower surface convex, mouth and anus alone being placed in a slight depression. Actinostome small, pentagonal; bourrelets and phyllodes very rudimentary, — the former reduced to small smooth interambulacral spaces, the phyllodes to a couple of large buccal pores. Anal opening narrow, longitudinally elliptical, half-way between the edge and the actinostome; does not equal in length the diameter of the mouth. The greatest diameter of the test may be either anterior or posterior to the apical system, the outline from above and in profile being extremely variable. Tuberculation regular, distant; miliaries closely packed.

Longitudinal Diameter.	Transverse Diameter.	Height.
10.	8.2	7.9
7.	6.5	5.4

There is great difference in the size of the jaws in the two species of Fibularia; in F. volva they are exceedingly small, scarcely projecting beyond the auricles, while in F. ovulum they are large and more prominent, much as we find them in Echinocyamus. The peculiar pits between the radiating ridges, so prominent in the plates of the interior of Echinocyamus, exist also in all the species of Fibularia, but are less marked; they are more prominently

developed in this species than in any other of the genus, although, both in this species and in F. volva, no trace whatever of the rudimentary anal radiating partitions existing in Fibularia australis exists. In this species the pores of older specimens are very indistinctly conjugate.

Indian Ocean; Philippine Islands.

Fibularia volva

! *Fibularia* **volva** Agass., 1847, C. R. Ann. Sc. Nat., VII. p. 142.

This species is elongate, pointed at both extremities, flattened from above, regularly arched; edge of test rounded; mouth slightly posterior; anus very small, placed close to the mouth; actinal side convex, re-entering towards the actinostome; ridges of the median part of interambulacra prominent on the lower side, near the anterior extremity; indistinct on the abactinal side. In one of the specimens examined the buccal and anal membranes were still preserved, and on opening the specimen very minute and delicate jaws could be seen, though the auricles were highly developed, — fully as well as in Echinocyamus. To the homology of the auricles I will return again when speaking of the Cassiduloids proper, to show that it is by no means safe to ascribe jaws to Clypeastroid genera from the presence of auricles alone, even when apparently well developed.

The tubercles of this species are large, distant on the abactinal side, but closely packed together on the actinal side; as they approach the actinostome the miliaries are larger and more prominent than in other species. The diverging petals are formed of from four to six large distant pairs of pores; the poriferous zones are continued by isolated distant pores to the actinal side close to the actinostome. The actinostome is covered, as in Echinonëus, with a membrane stiffened by minute calcareous plates, arranged concentrically round the central opening of the mouth; the actinostome is not central, it is placed somewhat nearer the posterior edge.

Longitudinal Diameter.	Transverse Diameter.	Height.	Distance of Anus from Mouth.
8.8	5.6	4.	1.1
8 5	6.	4.1	.9

Red Sea; Formosa; North Australia.

ECHINANTHIDAE.

Subfamily **Echinanthidae** A. AG., 1872, Rev. Ech., Pt. II. p. 306.

This subfamily comprises large species, with pillars or needle-like projections connecting the two floors, with straight ambulacral furrows; jaws articulating upon two auricles, the petals having a great degree of development.

CLYPEASTER.

Clypeaster LAMK., 1816, An. s. Vert. (MÜLL. emend.)
(See Part II. p. 306.)

Clypeaster humilis
! *Echinanthus* **humile** LESKE, 1778, KL. Add., *Pl. XIX. f. A B.*
! *Clypeaster humilis* A. AG., 1872, Rev. Ech., Pt. I. p. 100.

Pl. XI^a. f. 1–8.

This species is distinguished by its long odd anterior ambulacral petal, and the great width of the poriferous zone at the extremity of the petals. The petals are usually closed; poriferous furrows crowded at extremity of petals; they are characterized by their uniform breadth, and somewhat swollen median tuberculiferous part rising above the poriferous zone. The pores of the poriferous zone are large, — larger than in the other species of the genus; the outer pore especially is of great size. The genital openings are distant. The tubercles of the upper part of the test are somewhat smaller than in the West India species. On the actinal side the tubercles increase in size towards the actinostome, and become quite large, especially near the median interambulacral space; the space occupied by the miliaries between the primary tubercles is wider than in the West India species. In a very large specimen (C. latissimus), measuring 245^{mm}, the edge is extremely attenuated; the outline still more undulating than in smaller specimens, but not pentagonal, as is so frequently the case in the West India species. The proportions of the petals in the rosette are not changed in this large specimen; the median ambulacral space is less swollen, and the petals somewhat pointed; the tuberculation was remarkably uniform on both sides. In a very young

specimen ($23^{mm.}$) all the prominent characters described in the young of C. subdepressus were noticed, — the circular outline, short rosette, ambulacral pores in the horizontal sutures above and below; the odd ambulacrum was also already somewhat the longest.

Red Sea; East India Islands; New Caledonia.

Clypeaster rotundus

! **Stolonoclypus rotundus** A. AG, 1863, Bull. M. C. Z., I. p. 25.
! *Clypeaster rotundus* A. AG., 1872, Rev. Ech., Pt. I. p. 100.

This species is distinguished from its Eastern representative, C. subdepressus, by its depressed test, more circular outline, and the spindle-shaped outline of the ambulacral rosette, which has its greatest width nearer the centre instead of nearer the extremity, as in the West India species. The rosette, in fact, is similar to the rosette of the young of C. subdepressus; the poriferous zone is broader; the summit of the test more rounded. The edge of the test is thin. The lower surface of the test is more flat, the mouth not being sunk as deeply as in C. subdepressus. But the principal features which prominently characterize this species are the small size of the primary tubercles of the test, especially in the abactinal part of the test; those on the lower surface, though slightly larger, are not as large as the dorsal tubercles of C. subdepressus; apical system small; genital openings small, placed at angles of a smaller pentagon. Dried, the color is of an ashy-brown, which in life is more violet. Owing to the tenuity of the edge of test the limestone pillars extend more than half-way between the edge and the outer extremity of the ambulacral rosette.

The posterior pair of lateral ambulacra are somewhat longer than the anterior pair. The odd ambulacrum is intermediate in length between the two. The median ambulacral space, as well as the poriferous zone, is narrower in the odd ambulacrum than in either of the lateral petals; the lateral posterior petals are usually more open than the others.

Longit. Ant. Diam.	Transv. Diam.	Length Ant. Pair Amb.*	Length Post Pair Amb.	Width Ant. Odd Por. Zone.	Width Post Pair Por. Zone.	Width Inner Post. Pair Amb.	Width Inner Ant. Odd Amb.	Dist. of Genit. Pores.
92.	82.	25.	27.	3.	3.2	9.	8.2	1.4
112.	130.	36.	39.8	4.1	4.7	15.	13.	2.9

Panama; San Diego.

* In the ambulacral system of Clypeastoids and Spatangoids the measurements of the petals alone are given.

Clypeaster scutiformis

Echinus scutiformis GMEL., 1788, LINN. Syst. Nat.

! *Clypeaster scutiformis* LAMK., 1816, An. s. Vert., p. 16.

Pl. XIIIf. f. 1–4.

This small species would at first glance pass for an Echinanthus allied to E. testudinarius. It presents even outwardly several peculiar features which have led Desor and other authors to place it in the genus Laganum, on account of its swollen edge and of the depressed abactinal part of the test in some specimens. I have at one time considered it the type of a distinct genus. Test depressed. The general outline is somewhat elongated, pentagonal, with rounded angles, pointed anteriorly, and slightly re-entering sides in the posterior interambulacral; edge of test swollen. Petals extending to the inner line of the swollen edge of the test, the abactinal part of the test frequently quite flat, or rising but little towards the apex; the extremity of the poriferous zone of the petals somewhat concave; the concavity extending sometimes to the interambulacral spaces, and forming a continuous depression parallel to the edge of the test.

The ambulacral petals are broad, usually closed at the extremity; the posterior pair longer than the others, the anterior pair much shorter than the odd petal; the median interporiferous zone is narrow, acuminate, nearly of the same width in all petals, broadest in the posterior petals; while the poriferous zones are broad; the pores large, vertically distant. The abactinal system prominent; genital pores well marked. Seen in profile the test is somewhat arched; the anterior and posterior extremity both projecting beyond the level of the actinostome. The tuberculation is moderate, compact; on the actinal side the test is deeply scooped out; the outline of the actinal surface is concave; the ambulacral furrows are scarcely marked by the absence of tuberculation. The tubercles, which are large towards the edge of the test, diminish rapidly in the median interambulacral spaces till they approach the deeply sunken actinostome, when they become somewhat larger again; an irregularly tuberculated circular belt, bare in patches, is thus formed at a short distance from the actinostome. The anus is usually placed at a slight distance from the edge, from once to twice its diameter. Miliaries closely packed cover the whole test between the primaries; the primary spines are of uniform size, shorter on the abactinal side than on the actinal surface; the longest spines immediately surrounding the actinostome are striated; miliary spines very short and slender. The color of dried specimens

is brownish-gray, or mottled with yellow; the spines on the edges of the coronal plates are frequently of a light yellow color; on the actinal surface they are of a uniform brownish-pink tint.

In general appearance this species resembles closely young E. rosaceus. This resemblance extends, however, only to the exterior: when opened, we find the test thin; the whole actinal floor, except a third of the distance from the edge and a small space round the actinostome, bristling with needle-like pillars, leaving the principal passage from the intestinal canal adjoining the edge of the test. Only the outer and the interambulacral pillars extend to the abactinal floor; the petals are entirely free, and connect directly with the main intestinal cavity; the floors of this species are single and not double, as they are already in small specimens of Echinanthus.

It is possible that this species may prove the young of a still unknown adult Clypeaster, but thus far, in all collections I have examined, I have not found any species of Clypeaster which could, from what we know of the growth of our Atlantic species of Clypeaster, be supposed to be the adult of these small specimens. The largest specimens I have seen measure only 48$^{\mathrm{mm.}}$ in length.

Long. Diam	Trans. Diam.	Height.	Width Post. Porif.	Length Ant. Pair Amb.	Interp. Area.	Length Post. Pair Amb.	Interporif. Area.	Dist. Genit. Pores.
48.	36.8	14.	1.9	10.8		14.2		
44.5	34.3	9.2	1.3	9.2	2.3	12.	2.8	2.
42.	32.5	10.8	1.9	11.	2.5	14.	3.	1.7
32.	23.9	8.	1.9	9.	2.	10.9	2.2	1.1

Red Sea; Philippine Islands; Kingsmills.

Clypeaster subdepressus

! *Echinanthus* **subdepressus** GRAY, 1825, Ann. Phil., p. 5.

! *Clypeaster subdepressus* AGASS., 1836, Prod.

(See Part II. p. 306.)

Pl. XI^{b}.; Pl. XI^{e}. f. 1–2; Pl. XI^{f}. f. 25; Pl. XII^{d}. f. 4; Pl. XIII. f. 10–18; Pl. XXV. f. 24, 25. Pl. XXIX; Pl. XXX.

Florida; West Coast of Africa.

ECHINANTHUS.

Echinanthus Breyn., 1732, Schediasm. (emend.)
(See Part II. p. 310.)

Echinanthus rosaceus
Echinus **rosaceus** Linn., 1758, Syst. Nat.
! *Echinanthus rosaceus* Gray, 1825, Ann. Phil., p. 5.*
(See Part II. p. 311.)

Pl. XI^c.; Pl. XI^d. f. 1–2; Pl. XI^f. f. 1–18; Pl. XIII. f. 9; Pl. XXV. f. 23; Pl. XXVII. f. 6; Pl. XXVIII. f. 1, 2; Pl. XXXVII. f. 9, 11.

West India Islands; Florida.

Echinanthus testudinarius
! *Echinanthus* **testudinarius** Gray, 1851, Proc. Zoöl. Soc. Lond., p. 35.

Although the original specimens of Gray were erroneously mentioned by him as having been collected at Borneo by Captain Belcher, yet this species is also found in Australia, Sandwich Islands, and the Red Sea; it has been described by Michelin as a new species, and subsequently again by Verrill, from specimens collected in the Gulf of California. It has also been collected in Japan by Dall. The specimens contained in the different museums from these various localities vary but little in general aspect, the petaliferous part of the test being only more or less raised; the edges also are somewhat swollen, not arching as regularly as in the majority of the specimens examined. There is in this species far less variation in the outline, both in profile and from above, than in the common E. rosaceus, which is one of the most variable of Clypeastroids. When examined from the actinal side, we find a greater range in the flatness of the actinal part of the test. In some cases the actinal floor is nearly flat, the test near the actinostome sinks rapidly, and the mouth is situated in a deep cavity, while in other specimens the actinal part of the test slopes quite gradually from the edge of the test to the actinostome. The uniformity in the general aspect of the petals is much greater than in the eastern coast Echinanthus, although, as in all Clypeastroids, there is a certain variation in the terminal part of the petals: this is by no means as great as in E. rosaceus; the outer extremity widens but little, and is frequently nearly closed by the pores. The position of the

* On p. 311, 13th line from top, for Lam. 1816 read Lam. 1801.

anus is frequently its own diameter from the outer edge, but quite as often on the edge itself. The test is depressed; the outline is somewhat elongated, pentagonal, with rounded angles and slightly re-entering interambulacral sides. Ambulacral petals comparatively much shorter than those of E. rosaceus, narrower, more elongated; interporiferous zone often slightly raised; apical system small. Actinostome larger in comparison than that of E. rosaceus. Tuberculation of the test, both above and below, distant, and smaller than in the Atlantic species. The most striking differences between the Atlantic and Pacific species are at once seen on examining the interior. The double walls are limited to the edge of the test; the lower floor is single, as in Clypeaster, as well as the whole of the abactinal floor from a short distance beyond the extremity of the ambulacral petals; the pillars connecting the floors, which are so massive in E. rosaceus, are more slender and more numerous, less soldered together; and the whole of the lower and upper floors is lined with short limestone, needle-like pillars, rising only a short distance from each floor, resembling remarkably the structure of the interior in Clypeaster scutiformis, in which, however, there is no double floor at the edge of the disc. This species is interesting as showing the possibility of a passage between the Clypeastroids, with single and double floors. So that the position of C. scutiformis is by no means certain until we are sure that the specimens described are really full-grown, and that we may not, in the adult of that species, have gradually developed, with increasing size, the structural features of the species just described. The teeth are also proportionally much flatter and less powerful than in E. rosaceus. For a figure of a section of this species see Verrill's Notes on Radiata, *Pl. X. f. 7, 7^a*.

Long. Diam.	Trans. Diam.	Length Post. Amb.	Width Porif. Zone.	Length Ant. Amb.	Width Porif. Zone.	Interp. Zone Post. Amb.	Interp Zone Ant. Amb.
80.	59.	29.	3.1	25.	3.2	11.9	10.
93.	81.	33.	4.	29.	4.1	11.	9.1
92.	74.	31.	3 9	24.	3.8	10.8	9.2
112.	104.	43.1	5.2	36.	5.8	13.1	12.

Australia; Japan; Sandwich Islands; Gulf of California.

LAGANIDAE.

Subfamily **Laganidae** DES., 1857, Synops., 217. (emend.)

In this subfamily the connection between the two floors is made by walls running parallel to the edge of the test; well-developed buccal tubes; petals lanceolate; interambulacra extremely narrow on the actinal side of the test; ambulacral furrows straight, and outline more or less pentagonal.

LAGANUM.

Laganum KLEIN, 1734, Nat. Disp. Ech.

Echini of large and medium size, with depressed test, subpentagonal, often with swollen edge. Ambulacral petals lanceolate, closed before reaching the margin, scarcely extending beyond half-way between the apex and the margin of the test. Pores distinctly conjugated. Interambulacra narrow, especially upon the lower side, which is flat, with simple, broad, shallow, porous ambulacra running a short distance beyond the peristomal star, but not reaching the margin. Supports of the edge concentric with it, broad, and few in number; not more than two to three parallel rows of walls. The primary tubercles are uniformly scattered over the surface, and much less numerous than in the other Scutellae. The miliaries are more numerous. The teeth articulated upon a groove in the upper surface of jaws; the tip of the teeth alone is enamelled, and, although massive, the jaws are not quite built upon the pattern of the Clypeastroids, but are never like the jaws of Scutellidae. Anus infra-marginal. The outline is more or less pentagonal, angular or rounded anteriorly, and truncated posteriorly.

There are no pillars usually between the jaws and the alimentary canal; five genital openings; the upper and lower floors are perfectly smooth; the sutures of the plates of the petals are well seen from the interior. Several of the species of Laganum have a superficial resemblance to the flat Clypeastri; this has led to considerable confusion between the species of the two genera with Clypeaster scutiformis and Clypeaster humilis.

Laganum Bonani

!**Laganum Bonani** Kl., 1734, Nat. Disp. Ech.

Pl. XIII^e. f. 6–7.

The outline of this species is pentagonal, the longitudinal diameter slightly greater than the transverse; the posterior edge of the test is truncated, slightly re-entering. The greatest transverse diameter is slightly in advance of the apex, in a line with the anterior extremity of the anterior ambulacra. The test is thin, but the edge is greatly swollen, so that the apex rises but slightly above the edge; there is frequently a marked depression of the test between the summit and the edge. The apical system is small. The petals are large, extending to a short distance from the edge; they are lanceolate, nearly closed at the extremity; the five genital pores are in close proximity. The poriferous zones are narrow; the pores closely packed together, and connected by distinct grooves, the outer pores far the largest.

The posterior pair of petals are somewhat longer than the anterior pair; these in turn are slightly shorter than the odd petal, which has a narrower interporiferous space than the other ambulacral petals.

The tuberculation is remarkably uniform, the tubercles of the lower surface somewhat larger and more separated than those of the abactinal side; miliaries small and indistinct; the ambulacral furrows broad, marked, extending more than half-way between the actinostome and the edges of the test; the ambulacral pores are especially numerous near the actinostome. The anus is large, longitudinally elliptical, placed about half-way between the actinostome and the edge of the test; the anterior edge depressed. The mouth is large, pentagonal. The spines are uniform, those of the upper part of the test short, slightly club-shaped, while those of the actinal side are more slender and fluted. The few spines immediately around the actinostome are particularly long and slender. In a series of alcoholic specimens preserved in the Jardin des Plantes the color is brownish-yellow, with small round patches of black irregularly scattered on the interambulacra of the upper side of the test. The partitions of the interior are limited to a couple of thick concentric walls, diverging from the median interambulacral pillars, which radiate from the edge.

Long. Diam.	Trans. Diam.	Diam. Apical Syst.	Length Post. Pair Amb.	Length Ant Pair Amb.	Width Porif. Zone Ant. Pair.	Interp. Ant. Pair.	Dist. Apex from Post. Edge.	Dist. Anus from Edge.
36.8	33.2	2.	12.4	10.8	1.1	3.2	19.	7.1
32.	28.	1.9	11 5	9.	1.1	3.	17.	7.

Tasmania; East India Islands; Philippine Islands.

Laganum depressum

! *Laganum* depressum Less., 1841, in Agass., Mon. Scut. p. 110.

Pl. XIII. f. 5–8; Pl. XXXIII. f. 3, 4.

The synonymy of this species shows its great range of variation. The test is more flattened than in L. Bonani; the edge thinner, not swollen; the posterior extremity more angular. The anus is nearer the posterior edge, and is transversely elliptical, or circular; the apical system is larger. The tuberculation small and crowded on the abactinal side; on the actinal side the tubercles are larger, more distant, especially in the slightly depressed interambulacral spaces, where they are so far apart as to form fan-shaped areas, extending from the actinostome to the edge, where the tubercles are more distant than in the adjoining portion of the actinal surface. The ambulacral furrows are broad, extending nearly to the edge of the test. The peristomal star is distinct, while in L. Bonani it cannot be traced in any specimen I have examined. The spines of the abactinal and actinal sides are similar to those of the actinal side, longer, more slender, and more distinctly fluted; seen from the interior, the concentric walls of the edge of the test occupy a relatively broader space, and are more numerous than in L. Bonani. The jaws are powerful, high; the two posterior jaws much larger than the anterior ones; the odd jaw far the smallest. The petals in small specimens of $27^{mm.}$ in longitudinal diameter extend much nearer the edge than in L. Bonani; in older specimens measuring (L. Tonganense) $75^{mm.}$, longitudinal diameter, the outline becomes more angular, with re-entering sides. The petals extend but a short distance beyond half-way between the apex and the edge of the test. In these large specimens the anus becomes more circular. In alcohol the color is of a dirty yellow.

The greatest transverse diameter is placed behind the anterior pair of ambulacra in old specimens, while it is directly across the tip of the same in smaller specimens; the difference between the longitudinal and transverse diameter becoming less with diminishing size.

The pairs of pores are more separated as they near the tip of the petals, where they are quite distant, though nowhere in the poriferous zone are they as indistinctly conjugated as in L. Bonani; the grooves connecting them become obliterated with age. A fine series of this species, collected at New Caledonia, in the possession of Mr. Crosse, has enabled me to solve many doubtful points regarding the synonymy of this species.

Long. Diam.	Trans. Diam.	Length Ant. Pair Amb.	Length Odd Amb.	Dist. Anus from Edge.
79.	70.	20.5	24.9	10.
74.3	65.	19.	23.4	12.
57.1	49.	14.9	17.5	9.9
45.	41.	14.	16.	6.
35.8	32.	10.	11.4	5.
27.	23.	6.	7.	3.

Kingsmills Islands; Feejee Islands; Philippine Islands; Australia; Zanzibar.

Laganum Putnami

! *Laganum* **Putnami** BARN., 1863, in A. AG., Proc. Ac. N. Sc. Phila., p. 359.

From the figures and descriptions alone this species would be referred to L. stellatum; an examination of the originals has, however, shown that L. stellatum, from its internal structure, was only a young L. Peronii. There is considerable confusion in the identification of the species of Laganum with genital pores outside of the apical system, which can only be settled after examining the internal structure. Laganum Putnami would undoubtedly pass as a variety of L. Peronii, to judge from its exterior alone. It shows, when seen from the interior, only a couple of thin walls, concentric with the edge, as in all Laganum species, while in much smaller specimens of L. Peronii, the peculiar fan-shaped and radiating partitions and walls already extend a considerable distance towards the actinostome from the edge of the test. The outline of this species is quite pentagonal, with rounded angles, resembling in general facies L. depressum, concentric apex, but with more lanceolate and pointed petals, of uniform length, the anterior pair somewhat shortest; the genital openings placed at about one quarter the distance of the apex from the edge outside of the apical system. The median interambulacra rising from the apex as a bare rounded ridge from the apical system, and extending like spokes from the genital openings. The tuberculation is distant, small; the miliaries closely packed, minute; towards the edge the tubercles are larger and more closely crowded; on the actinal side they are large and well separated. The ambulacral furrows are deep, extending almost to the edge of the test. The anus of the only specimens I have examined, which were of same size, is about its diameter from the edge of the test.

Long. Diam.	Trans. Diam.	Post. Pair Amb.	Dist. Genit. Op. from Apex.	Dist. Anus from Edge.
29.4	25.9	10.4	4.6	2.1

Japan.

(LAGANUM.) Peronella.

Peronella Gray, 1855, Cat. Rec. Ech.

Agassiz had already hinted at the probable generic separation of L. Peronii from Laganum: this has been adopted without further proof by Gray, Desor, Michelin, and Hupé, who have independently established a distinct genus, based upon the peculiar position of the genital opening, far away from the abactinal system, in the interambulacra; but as we have a true Laganum in which the genital openings (L. Putnami) have the same extrapetaloid position, this feature alone cannot be of any generic value. I am inclined to adopt this group as a subgenus, but basing the distinction entirely upon the internal structure of the test in Peronella. The partitions forming the connecting walls between the upper and lower floor ramify somewhat as they do in Scutella and Arachnoides, and extend more than half-way to the centre of the test from the edge, instead of forming a narrow belt of three or four concentric simple walls near the edge. Four genital openings. In young specimens of P. decagonalis the partitions are already well developed.

Peronella decagonalis

! *Scutella* **decagonalis** Less., 1827, in Bl., Dict. Sc. Nat. Scut., p. 229.
Peronella decagonalis A. Ag., 1872, Rev. Ech., Pt. I. p. 148.

Pl. XIII^c. f. 8–11; Pl. XXXVII. f. 3.

This is the largest and most graceful of the species of Laganidae. Its origin having been till lately unknown, it has been described independently several times. Its external features are sufficiently striking to have led Agassiz to suggest its separation from Laganum; this suggestion was carried out first by Gray and subsequently by Desor. Michelin, Dujardin, and Hupé later described the species as new, and formed a genus for its reception. The test is very much flattened; the edges are scarcely swollen, with a slight depression between the edge and central portion of the test, as in Laganidae generally; the central part of the test rises somewhat abruptly at the extremity of the petals, and is regularly arched, but only rises to a moderate height even in the largest specimens. The outline is regularly decagonal; the test is truncated by ten sides, the longer sides corresponding to the interambulacral, and the shorter to the ambulacral areas.

The greatest width is anterior to the anterior pair of petals. The petals are narrow. The interporiferous zone is broad; the poriferous furrows closely packed, diminishing very gradually towards the extremity, where the poriferous zones converge slightly from the apical system towards the extremity, and are not rounded along the sides of the petals. The anterior petal is somewhat larger than the lateral petals. There are four genital openings. The actinal surface is perfectly flat. The actinostome is central, circular, with distinct ambulacral furrows extending nearly to the edge. The interambulacral areas on the lower surface form narrow well-defined bands. The anus is near the edge, elliptical, but placed obliquely to the longitudinal axis. The tuberculation of both surfaces is remarkably uniform, but, as in all Laganidae, much larger on the lower surface. The spines correspond to the difference in size of the tuberculation; those of the upper surface are small, slender, on the lower much larger and stouter; they are distinctly fluted, with minute serrations along the edge. There are no striking differences to be noted between the larger and smaller specimens. The pillars of the edge of the test are proportionally fully as developed in the young as in older specimens; the proportions of the petals are not different, though the decagonal outline is not quite as plainly marked. The color of dried specimens is yellowish-brown; alive they are said to be of a brilliant red color.

Long. Diam.	Trans. Diam.	Length Odd Petal.	Length Post. Pair Petals.	Width Porif. Zone.	Interporif. Space.	Dist Anus from Edge.
114.	104.5					
110.	100.	31.9	28.	1.9	4.	6.
107.	99.	31.	27.	1.9	3.9	6.8
49.5	42.	12.	10.5	.9	2.6	3.7
40.3	37.2					

Japan; New Caledonia; Bay of Bengal.

Peronella orbicularis

Echinodiscus **orbicularis** LESKE, 1778, Kl. Add., p. 144.
! *Peronella orbicularis* A. AG., 1872, Rev. Ech., Pt. I. p. 149.

I have but little doubt that this species will prove to be the young of Peronella decagonalis. Unfortunately all the specimens of P. orbicularis examined are too small to form the connecting link with the youngest specimens of P. decagonalis or of P. rostrata; there is, however, nothing markedly different which could not be accounted for by a difference of age. The more rounded outline, shorter petals, more swollen edge,

thicker and shorter radiating walls and pillars, which distinguish this species from P. decagonalis, are merely features greatly modified by age. Not to introduce needless confusion, I give the points of difference between the specimens.

The outline is nearly circular; the edge of the test slightly swollen; the abactinal surface slightly depressed at the extremity of petals, where the test is covered by large glassy tubercles similar to those observed in the young of C. subdepressus. Petals broadly lanceolate, extending more than half-way to the edge; anterior pair slightly shorter than the others; poriferous zone narrow; poriferous grooves sharply cut; poriferous zone broadest near the extremity of the petals; four distant genital pores, one very indistinct; anus transversely elliptical, placed about three times its diameter from the edge of the test. Ambulacral furrows indistinct, extending only a short distance from the actinostome.

Long. Diam.	Trans. Diam.	Ant. Pair Petals.	Post. Pair Petals.	Dist. Anus from Edge.
23.8	22.	5.	5.4	3.

New Holland; Formosa.

Peronella Peronii

! *Laganum* **Peronii** Agass., 1841, Mon. Scut., p. 123, *Pl. XXII.*
! **Peronella** *Peronii* Gray, 1855, Cat. Rec. Ech., p. 13.

Pl. XIII.f. 4–5.

Professor Agassiz first called attention to the striking differences existing among the specimens of what had usually passed as Laganum orbiculare, distinguishing the species with four genital openings situated in the apical system (P. orbicularis) from the present species, usually confounded with it, in which the genital openings (four) are placed in the ambulacral spaces at a considerable distance from the apex. The general outline is circular; test thick; edge slightly swollen; the petals broadly lanceolate, similar to those of P. orbicularis. The mouth transversely elliptical, placed at about one third the distance between the edge and the actinostome from the former. Tuberculation, as in P. orbicularis, distant, quite uniform on both the actinal and abactinal surfaces. Ambulacral furrows indistinct, extending but a short distance from the mouth. The interior already shows the fan-shaped and

radiating partitions extending nearly over half the lower floor from the edge of the test in specimens of which the dimensions are given below.

Long. Diam.	Trans. Diam.	Dist. Genital Pores from Apex.	Length Post. Pair Amb.	Dist. Anus from Edge.
26.	23.5	4.	7.	4.8

Tasmania; Philippine Islands.

Peronella rostrata

! *Laganum* **rostratum** Agass., 1841, Mon. Scut., p. 118, *Pl. XXV.*
! *Peronella rostrata* A. Ag., 1872, Rev. Ech., Pt. I. p. 149.

The only authentic specimens of this species I have been able to examine are in the Jardin des Plantes and the École des Mines; the material representing this species is too scanty to arrive at a definite solution of its affinities. It is evidently a Peronella. The elongate form, the position of the anus, and structure of the spines surrounding it, its conical outline seen in profile, the thickness of the test, the comparatively greater size of the ambulacral petals, and short ambulacral furrows, distinguish it apparently from its congener, P. decagonalis; but, as I have already suggested, it may prove to be only the adult of Peronella orbicularis, which has, although all the specimens of it examined are small, points of resemblance to the present species, such as we may naturally expect to find between the old and young of species in this genus.

New Zealand; Zanzibar.

SCUTELLIDAE.

Family **Scutellidae** AGASS., 1841, Mon. Scut. (emend.)

In this family the test is reduced to its extreme flatness among Clypeastroids; the outline is more or less circular, and is, unlike the Euclypeastridae, frequently perforated or cut at the margin, so as to form either ambulacral or interambulacral cuts and lunules. The ambulacral furrows of the actinal side are more or less branching and anastomose, spreading over to the interambulacral spaces. The connection between the upper and lower floors is made by partitions, radiating fan-shaped from single points. The tubercles of the two sides of the test, as well as the spines which they carry, differ greatly in size. The absence of rotulæ characterizes the jaws of the Scutellidae; they are extremely flat in some genera, articulating directly upon very low auricles, and the teeth are horizontal instead of being vertical as in Euclypeastridae.

(SCUTELLA.) ECHINARACHNIUS.

Echinarachnius LESKE, 1778, Kl. Add.
(See Part II. p. 315.)

Echinarachnius excentricus

Scutella **excentrica** ESCH., 1829, Zoöl. Atl. *Pl. XX. f. 2.*
? *Echinarachnius excentricus* VAL., 1846, Voyage Vénus, *Pl. X.*

Pl. XIII^a. f. 1–4.

This is the largest of the species of the genus; the test is thick; the outline from above is nearly circular, elongated anteriorly, slightly truncated posteriorly. The apical system is eccentric posteriorly, about one quarter the distance of the vertex from the edge of the test. The apical system is large; the posterior pair of genital openings twice as far apart as the anterior, owing to the eccentricity of the apex; the ambulacral petals are very unequally developed. The ambulacral pores of the lateral pairs of petals are continued by three or four pairs diverging from the extremity of the petals towards the edge, while the poriferous zone of the odd petal is continued by pores, becoming more and more distant, forming a distinct reversed curve as a direct continuation of the gradually narrowing poriferous zone to within a couple of plates of the edge of the test. The

odd anterior petal is by far the longest, acuminate, with a broad interporiferous space, enclosed by a narrow poriferous zone. The anterior pair are somewhat shorter, rounded at the extremity; the interporiferous area narrow, bounded by broad poriferous zones. The posterior pair of ambulacra are still shorter, scarcely more than half as long as the odd anterior ambulacrum, with broad poriferous zones, open and rounded at the extremity; the anterior poriferous zone not regularly arched like the posterior zone, but decreasing very rapidly in width near the apical system. The vertex is eccentric posteriorly; the test slopes gradually from the thin edge to the extremity of the petals, and then it is regularly arched. The lower surface is flat; mouth nearer the posterior edge, corresponding to vertex; the anus is placed at a distance from the edge, from two to three times its diameter The ambulacral furrows are very unequally developed; they cover with their ramifications the whole of the posterior half of the actinal surface, but extend only a little more than half-way between the mouth and the edge of the test in the anterior half. Portions of the ambulacral furrows extend even beyond the edge to the abactinal part of the test, reaching, in the three posterior interambulacral spaces, the level of the ambulacral petals, and in the petals sending two branches, one of which extends nearly to the abactinal system in the interporiferous zone of the two pairs of petals. The ambulacral furrows are broad and deep; near the somewhat sunken actinostome they spread fan-shaped for a short distance, and then send out two branches, which run in continuation of the direction of the outer line of the furrow, and then run nearly parallel towards the edge of the test; each main furrow sending off a branch at right angles, extending into the interambulacral area, which trends towards the edge of the test at its extremity. Numerous short spurs are sent off from the furrows at right angles generally to the general trend of the branches or main furrows, which in their turn may branch again. The ramifications of the furrows are very variable, specimens of the same size frequently possessing numerous small offshoots for the whole length of the furrows and of their branches, while in others we have only the main furrows and the principal branches, with here and there an occasional short spur. The anterior ambulacral furrow, which is so much less developed than the others, branches but once, and frequently remains simple at its extremity, which does not extend to more than two thirds of the distance from the actinostome to the edge of the test. The tubercles of the actinal side are much larger than those of the abactinal side; they are especially large

between the ambulacral furrows and their ramifications, decreasing but little in size towards the edge of the test in the posterior half of the actinal surface, while in the anterior half they are much smaller and more closely packed, arranged like those of the upper side. The spines of the upper surface are slightly club-shaped, short; those of the lower sides are longer, more slender. The color when alive is of a grayish-green both above and below.

The calcareous partition walls and pillars connecting the two floors are quite indistinct near the edge of the test, forming a nearly solid edge, with but few narrow parallel and diverging channels; towards the centre they become distinct, but are more numerous than in either of the other two species of the genus, leaving but a narrow median ambulacral space free. The interambulacral pillars extend half the distance from the edge to the apical system both in the odd posterior and posterior lateral ambulacral regions, and half-way to the vertex in the anterior interambulacral spaces. The grooving of the lower floor by low ridges running at right angles to the ambulacral tube is very prominent, while the similar sculpture of the lower floor of E. parma and E. mirabilis is not very prominent. The auricles are low but strong, and connected at their base by a broad ridge running round the edge of the actinostome, which in the other species of the genus is scarcely apparent. The anus is placed at a distance of one and a half to three times its diameter from the posterior edge.

Long. Diam.	Trans. Diam.	Dist. of Mouth from Post. Edge.	Dist. of Apical Syst. from Post. Edge.	Length Ant. Pair Amb.	Length Post. Pair Amb.	Dist. of Genit. Pores Ant. Pair.	Dist. of Genit. Pores Post. Pair.
87.	94.7	43.4	35.	35.	25.4	5.8	8.1
79.	82.3	35.	27.4	31.	20.	5.	9.
57.2	62.3	26.2	21.	21.	13.8	3.	4.2

California; Kamtschatka.

Echinarachnius mirabilis

! **Scaphechinus mirabilis** BARN., 1863, in. A. AG., Proc. A. N. S. Phila., p. 359.
! *Echinarachnius mirabilis* A. AG., 1872, Rev. Ech., Pt. I. p. 107.

Pl. XIII^a. f. 5–6; Pl. XXXVII. f. 7, 8.

Outline from above pentagonal, with rounded angles anteriorly, while the two sides of the pentagon forming the posterior interambulacral space, at the angle of which the anus is placed, form a sharper angle; the median ambulacral spaces somewhat re-entering along the edge of the test, especially the two

posterior ambulacral areas. The edge of the test varies greatly in thickness; it is more or less swollen and slightly convex on the abactinal side, or has a thin edge, especially in younger specimens, which slopes gradually to the apex. Apex (organic and geometric) eccentric anteriorly, particularly in specimens where the posterior interambulacral space is pointed. In young specimens the anterior part of the test is quite rounded, angular posteriorly; the broadest part of the test is then greater across the median posterior pair of ambulacra; with increasing size the outline becomes somewhat more circular, but the greatest breadth remains at the same point. The median interambulacral areas are in old specimens slightly sunken; this feature is subject to great variations, as we frequently find specimens in which no trace of this depression exists. The anus is placed on the edge of the test, rather more on the upper side. The four genital openings are distant; the posterior pair somewhat farther apart than the anterior pair. The apical system is comparatively larger than in E. parma. The ambulacral petals are of uniform size, equally developed, extending about two thirds of the distance from the apex to the periphery; the poriferous zone is broad, two thirds as broad as the enclosed ambulacral space; the petals of the lateral ambulacra are almost closed at the extremity; the odd petal is usually more open at the extremity than the lateral pair. The tuberculation of the abactinal part of the test is close and uniform in size, slightly smaller in the median ambulacral and interambulacral areas; on the actinal surface the tubercles are largest near the edge of the test, near the actinostome, and on the sides of the ambulacral furrows, leaving a space of smaller ones between these two points. On the lower side the ambulacral furrows begin to branch at a distance of about two thirds from the edge of the test, each branch forking again somewhat nearer the edge, or sending one or two irregular smaller branches from the furrows, which do not extend beyond the edge of the test on the lower side, meeting the scattered pores which diverge from the extremity of the petals and extend to the edge of the test. The ambulacral furrows are deep and broad as far as the first bifurcation. The spines are short on the abactinal surface, somewhat club-shaped, and considerably longer, more slender and cylindrical on the actinal side, corresponding to the smaller or larger tubercles of the edge of the test and ambulacral furrows. According to Stimpson and Martens the color in life is dark violet.

The jaws are flatter and more slender than those of E. parma; the connecting pillars and walls between the two floors extend nearly one half the

distance from the edge of the test to the centre, leaving narrow ambulacral passages.

Long Diam.	Trans. Diam.	Dist. Ant. Pair Genit. Pores.	Dist. Post. Pair Genit. Pores.	Ant. Pair Amb.	Width Porif. Zone.	Interporif. Zone.	Post. Pair Amb.
69.2	73.7	4.2	6.2	19.9	3.	5.6	19.5
69.9	70.1	4.	7.	21.5	3.8	5.	21.4
58.2	59.	3.4	5.3	15.	3.	3.9	14.8
29.6	34.	1.9	2.2	8.	1.9	2.5	8.

Japan.

Echinarachnius parma

! **Scutella parma** LAMK., 1816, An. s. Vert., p. 11.

! *Echinarachnius parma* GRAY, 1825, Ann. Phil., p. 6.

(See Part II. p. 316.)

Pl. XI^d. f. 4–5; Pl. XI^e. f. 4–5; Pl. XII. f. 1–13; Pl. XXV. f. 38–41; Pl. XXVI. f. 15–18; Pl. XXXI.

The range of this species is quite remarkable, occurring as it does on both sides of the Pacific and one side of the North Atlantic. I have carefully compared the specimens from the different localities, and can find no valid grounds for considering them distinct species.

There is, however, some doubt of the correctness of some of the localities, as, for instance, the Red Sea, which is found on labels both of the Jardin des Plantes and the École des Mines. There seems no reason to doubt the authenticity of the Australian specimens.

New Jersey; Labrador; Vancouver Island; Kamtchatka; Australia.

ARACHNOIDES.

Arachnoides KLEIN, 1734, Nat. Disp. Ech.

Test depressed, conical; outline circular. Anus supramarginal; four and five genital pores in the only species known. Interambulacra sunken below the level of ambulacra. Ambulacral furrows simple, and extending from the actinostome in an unbroken line to the apical system. Tubercles of ambulacra, both the primaries and miliaries, arranged in oblique lines across the plates, both on the actinal and abactinal surfaces. The interambulacral tuberculation is coarse and irregularly arranged, having the general features of allied genera, though remarkably larger tubercles, and less crowded, on the

actinal than on the abactinal side. In the buccal rosette the arrangement is the same for both areas. Adjoining the actinostome the ambulacral furrows are broad, lanceolate, but carry no pores in any part of the furrow. The internal structure of the pillars is very different from that of Echinarachnius; the walls are numerous, slender, frequently radiate or branch as in Peronella, though they retain a general parallelism to the outer edge; they extend nearly two thirds of the distance from the edge to the centre. We have no solid interambulacral walls separating the interambulacral spaces, so as to leave a broad bare triangular space, as in Echinarachnius, or as we find it to a less degree in Mellita. The interambulacral walls are similar to the ambulacral, arranged somewhat more fan-shaped; the walls having, besides the median free ambulacral spaces, three others (one median interambulacral and two lateral ambulacral), more or less distinct, separating the interior into a number of triangular spaces; the general arrangement of the walls of each of which are repeated, or nearly so, in each ambulacral and interambulacral space.

The jaws are remarkably flat, more like those of Echinodiscus than the solid massive ones of Echinarachnius. The central part of the jaws is remarkable for the high crest rising on each side of the dentiferous furrow.

The petals are diverging, sometimes even arched outwardly, so that, on this account, and from its smaller width, the interambulacral space might be mistaken for the ambulacral. The pores are conjugated to about half-way between the apex and the edge, the petals extending no farther; the poriferous zone is continued in the same general direction by isolated pairs reaching to the circumference. The ambulacral sutures running parallel to the edge are riddled by pores, very much as we find them in young Clypeaster, and extend also to the ambulacral space, enclosed by the petaliferous part of the poriferous zone. The auricles are peculiar; they are two independent, stout, short pillars, separated by a deep notch, instead of the low, thin, indented auricles so common among the Scutellidae.

The separation of Arachnoides from the Scutellidae seems to me unnatural; the whole of its internal structure (the teeth and partitions) points to a close relationship with the Scutellidae, and not with the Laganidae, as suggested by Müller, and accepted by Desor, with which it has only the straight simple ambulacral furrows in common.

Arachnoides placenta

Echinus placenta LINN., 1758, Syst. Nat.

! *Arachnoides placenta* AGASS., 1841, Mon. Scut., p. 94.

Pl. XIII^b. f. 1–4.

Gray has attempted to distinguish two species in this genus; a careful comparison between his specimen and specimens of the same size of A. placenta show no differences which can be considered as specific. The outline is, seen from above, slightly angular, nearly circular. The edge of the test is thin, the profile slightly conical; the greatest diameter immediately across the extremity of the posterior pair of petals; the poriferous zones are narrow, nearly of uniform breadth the whole length; the poriferous grooves are deep; the ambulacral regions are broader than the interambulacral, both on the actinal and abactinal part of the test. The petals can scarcely be called such, as the poriferous zones diverge regularly from the apex towards the outer edge, curving even outwardly at the extremity towards the median interambulacral space. The conjugated portion of the poriferous zones extends to about half-way between the apex and the edge. The apical system is compact, slightly raised, like a button, above the level of the depressed interambulacral spaces, which are especially sunken near the apex between the poriferous zones. The anus is supra-marginal near the edge; in younger specimens it is somewhat more distant. The peristomal star is small, remarkably well defined, regularly pentagonal. The posterior genital opening is frequently wanting. Apex slightly posterior; anus angular, comparatively smaller than in other genera of the family; outline slightly indented opposite anus, forming projecting angles; the young are quite pentagonal.

Long. Diam.	Trans. Diam behind the Ant. Pair.	Length Petals Post. Pair.	Interporif Extension of Petals.	Apical System.	Dist. Apex to Edge Post	Dist. Anus from Edge.
72.	75.	18.4	12.8	3.	38.	4.
55.5	57.	13.	12.3	2.5	27.	1.5
44.	45.4	11.	9.	2.1	21.	1.
38.	39.	11.2	5.	1.7	18.8	1.2
29.	29.5	6.9	5.	1.4	14.	2.

New Zealand; Australia; East India Islands; Burmah.

ECHINODISCUS.

Echinodiscus BREYN., 1732, De Echin. Schedias. (LESKE emend.)

The test in this genus is more depressed than in any other of the Scutellidae; the test is thin; anterior edge rounded; posterior edge truncated. There are two lunules or cuts corresponding to the posterior ambulacra. Ambulacral petals small, well limited. Four genital pores. Lower surface flat; ambulacral furrows ramify but little towards the exterior edge. Anus nearer the posterior edge than the actinostome. The greater part of the interior of the test is occupied by a calcareous network rising into pillars for more than half the distance between the edge and actinostome, leaving the central part more or less covered by a delicate tracery of limestone cells, into which the appendages of the alimentary canal are received. There are no pillars or partitions separating the buccal cavity from the alimentary canal. The alimentary canal is slender, having the same general course as in other Scutellidae, with the exception of a lateral fold, previous to its turning towards the anus in the right anterior ambulacral space. The jaws, which are extremely flat, articulate upon the auricle, which fits in a pit in the middle of the lower surface of the jaw, and are not enclosed by them, as in other Scutellidae. The spines are uniform in structure; those of the upper surface are only shorter and slightly clavate.

Echinodiscus auritus
Echinodiscus **auritus** LESKE, 1778, KLEIN, Add.

Pl. XI^a. f. 9–13; Pl. XIII^c. f. 1–3.

This is the largest and most common species of the genus. The test is depressed, rounded anteriorly; the greatest width about half-way between the apex and posterior edge; anterior extremity much narrower than the broadly rounded and truncated posterior extremity. The vertex is somewhat anterior, and corresponds with the apex. The petals are small compared to the size of the test, and, judging from the specimens examined, do not increase in size in proportion to the increase of the test. The genital pores, four in number, are distinct, diverging posteriorly rather more than in the other species of the genus. The petals are nearly of the same size; the odd petal is somewhat longer than the others. The petals

are rounded at the extremity, closed; the poriferous zones are broad, equalling in width the interporiferous space.

The lunules are more or less closed, or simply form open slits, extending over one third the distance of edge from the apex towards the centre, in prolongation of the median longitudinal axis of the posterior pair of petals. The tuberculation of the upper surface is small, compact, of uniform size, carrying minute, short, fine spines, slightly clavate. The median interambulacral and ambulacral spaces are covered with larger and more distant tubercles, decreasing in size near the edge, carrying longer and stouter spines. The interambulacral spines are more brilliantly colored than the ambulacral. The ambulacral furrows are not deeply grooved; the posterior pairs branch more frequently near the edge than the others. The mouth is nearly central, slightly anterior. The anus is of irregular outline, more or less circular, placed in a line with the inner extremity of the cuts. The color of dried specimens is violet or reddish-brown as they become older, to judge from dried specimens.

Half the internal cavity is occupied by a close net-work of pillars, occupying the whole space from the edge; between the commencement of the pillars and the slender auricles the whole actinal floor is covered by a succession of elongated cells, of the most irregular shapes, formed by the rising of thin lamellæ or ridges from the floor, which form eventually the pillars extending to the upper floor, as is readily seen on examining the base of the innermost row of pillars, arising directly from the continuation of the walls of those cells which have risen sufficiently above the lower floor to form pillars, and to reach the upper floor. The net-work across the ambulacral spaces is reduced to short low ridges, running at right angles to the ambulacral tubes.

Long Diam	Trans Diam.	Length Post. Pair Petals	Width Por Zone	Interp Zone.	Length Odd Petal.	Length Lunule.	Dist. Anus from Edge.	Dist. Mouth from Ant Edge.
133.	139.	26 2	4.	4.1	30.	30.	30 1	64 5
155.	157.	30.1	3.9	5.2	35.	38.5	32.	72.4

Zanzibar; Philippine Islands.

Echinodiscus biforis

Echinodiscus bisperforatus Leske, 1778, Kl., Add.
! *Echinodiscus biforis* A. Ag., 1872, Rev. Ech., Pt. I. p. 113.

Pl. XIII^b. f. 5–6; Pl. XXXVII. f. 4–6.

The outline is irregular, narrower anteriorly, rounded and slightly indented opposite the anterior lateral ambulacra. Greatest breadth about half-way

between the apex and edge of the test; posterior extremity truncated, slightly indented in the direction of the anal opening. Test much thicker than in the other species of the genus. Vertex anterior; apical system nearly central. The posterior pair of petals are quite short; the anterior pair somewhat longer, but still considerably shorter than the odd petal. The outline of young specimens is triangular, with rounded angles.

The lunules are very long, narrow, sometimes narrower in the middle part, forming an obtuse angle with the prolongation of the median axis of the posterior petals. Seen from the actinal side, the ambulacral furrows are deep, sharply cut, branching only once or twice quite near the edge; they are very prominent, as they are edged on both sides by minute tubercles, closely packed, giving them the appearance of bare bands, greatly contrasting with the coarse distant tuberculation of the remaining part of the actinal surface. In the interambulacra the largest tubercles are placed along the bare bands of the furrows, becoming smaller towards the median line and edge of test, while in the three anterior ambulacral spaces the largest tubercles are in the median space near the edge of the test, diminishing gradually in size towards the actinostome. The mouth is small, almost central; lobed. The anus is small, circular, placed near the edge. The interior limestone network is very compact, extending to the extremity of the petals, and leaving only a small open space; this is, however, completely smooth, showing no trace, except a few ambulacral pits, of the delicate tracery covering the floor of the other two species. The auricles are extremely small and low; the teeth remarkably flat, even for this genus. The spines were not preserved in any of the specimens I have seen. The color of dried specimens is dull olive-brown.

Long. Diam	Trans. Diam.	Length Post. Pair Petals.	Length Odd Petal.	Length Lunules.	Dist. Anus from Edge.
76.	91.	13.	18.8	26.2	4.9
83.	100.			31.	5.4
25.9	29.9	3.8	6.	7.1	1.

Mozambique; Red Sea; Java.

Echinodiscus laevis

! **Mellita laevis** KLEIN, 1734, Nat. Disp. Ech.

! *Echinodiscus laevis* A. AG., 1872, Rev. Ech., Pt. I. p. 113.

It is with considerable doubt that this species has been retained, although I have examined considerable material representing from different localities the E. auritus and E. laevis, and am not confident of having succeeded in discriminating satisfactorily this species from its nearest ally, E. auritus.

This species does not attain so great a size as E. auritus. It is more circular, but slightly truncated posteriorly; though in young specimens the general outline resembles more that of E. auritus, and in them the position of the vertex is slightly anterior to the apex, while in the larger specimens they coincide. The rosette is somewhat different from that of E. auritus; the median interporiferous space is broader; the posterior pair of ambulacra are much shorter than the odd anterior one. The lunules are small, closed, more or less elliptical. The general structure of the tuberculation and of the spines does not differ essentially between the two species on the upper side; on the lower side, however, the spines are larger and stouter, and are carried upon larger and more distant tubercles in the median ambulacral and interambulacral spaces. The anus is placed much nearer the posterior edge, being placed on a line drawn through the middle of the lunules.

The coloration of this species is rather more violet than that of E. auritus in dried specimens. According to Stimpson the color is dark red when alive; darkest below. Seen from the inside, the limestone tracery of the lower floor differs considerably from that of E. auritus. The reticulation of the ambulacra at right angles to the tube is highly developed, forming an elongated rosette, beyond the buccal rosette at the base of the auricles, leaving the interambulacral space nearly smooth, while in E. auritus the reticulation covers the whole actinal floor. The size of the jaws is comparatively larger; the auricles are more distant.

Long Diam	Trans. Diam.	Length Post. Pair Petals	Width Interp. Space.	Width Porif. Zone.	Length Ant. Petal.	Length Lunules.	Dist. Anus from Edge.
126.	121.	20.	5.	3.5	24.	15.4	19.
75.	82.	16.	4.9	3.3	19.1	11.3	5.

Japan; New Caledonia; East India Islands; South Africa.

MELLITA.

Mellita Klein, 1734, Nat. Disp. Ech. (pars.)
(See Part II. p. 319.)

Mellita erythraea

! *Mellita* **erythraea** Gray, 1851, Proc. Zoöl. Soc. Lond., p. 36.

There are preserved in the Jardin des Plantes and in the British Museum specimens of this species marked as coming from the Red Sea. It is the

analogue of the hexapora type; differs, as far as the few specimens existing show, from the Panama species in the size of the lunules, which are longer, more as in M. hexapora, while the position of the apex is intermediate between the two. The outline in profile is regularly conical; the tuberculation is large but distant; the petals are small, of uniform length, with very broad poriferous zones, broader than in either of the American species. The locality of these specimens is said to be undoubted. The material existing is not in a sufficiently good state of preservation to discriminate the three hexaporous species of this genus more accurately.

Red Sea?

Mellita longifissa

! *Mellita* **longifissa** MICH., 1858, Rev. Mag. Zoöl., No. 8.

Pl. XI. f. 24–27.

This species is readily distinguished from its Atlantic representative (M. testudinata) by its long and narrow lunules; the posterior interambulacral lunule is especially developed. The anterior extremity is quite rounded; edge of test thin; the posterior extremity truncated. The development of the petals is very unequal; the posterior pair are long, arched, much as in some species of Encope, with an extremely narrow interporiferous space; the anterior pair are short, making a more decided angle with the general trend of the median ambulacral line than in M. testudinata. The apex is more anterior, and the apical system comparatively smaller, than in M. testudinata. The odd anterior petal is somewhat longer than the anterior pair, with a wider interporiferous space, much as in petals of M. testudinata. There is no special difference on the actinal side, as regards the general appearance of the ambulacral furrows; the interambulacral spaces are broader proportionally than in the Atlantic species, and their general tuberculation slightly larger and more uniform in size. The mouth, owing to the extreme length of the posterior lunule, is very eccentric anteriorly, the anus being placed nearly in the centre of the actinal side.

Long. Diam.	Trans. Diam.	Length Post. Lunule, above.	Length Ant. Lunule.	Length Post. Pair Petals.	Width Interp. Space.	Length Ant. Pair Petals.	Width Interp. Space.	Dist. Ant. Genital.	Dist Anus from Ant Edge	Dist. Mouth from Ant Edge.
53.2	60.	21.	15.	15.	1.	9.1	1.4	3.	28.7	19 5
51.	55.	15.	10.	13.		8.			25.5	21.

Panama; Gulf of California.

Mellita pacifica

! *Mellita* **pacifica** VERRILL, 1867, Notes Rad., p. 313.

I am inclined to believe that this species will prove to be large specimens of Mellita Stokesii. The only specimen of it found thus far is so much larger than any specimens of M. Stokesii that no direct comparison can be instituted. The more striking points of difference are the central position of the vertex, and the peculiar position of the posterior interambulacral lunule, in front of the two posterior lunules, while it is behind in M. Stokesii. This lunule is placed half-way between the edge and apex, instead of being placed in the immediate vicinity of the edge, as in all specimens of M. Stokesii thus far examined; this removes the anus close to the mouth. The similarity of the ambulacral furrows with those of M. Stokesii is quite striking. The closed anterior or posterior lunules also occur in M. Stokesii, as is seen in specimens collected at Panama by Dr. Maack. These differences are, I am aware, no greater than variations noticed in the different species of Encope. In Mellita, however, so far as known, the differences in the characters mentioned above are not so great as in the species of Encope.

The color of the dried specimen in the museum at Yale is deep green.

Peru; Panama.

Mellita sexforis

Echinodiscus **sexiesperforatus** LESKE, 1778, Kl. Add.
! *Mellita sexforis* A. AG., 1872, Rev. Ech. Pt. I., p. 141.
(See Part II. p. 320.)

Pl. XI. f. 1–12; Pl. XI^d. f. 3.*

West India Islands; Florida.

Mellita Stokesii

! *Encope* **Stokesii** AGASS., 1841, Mon. Scut. p. 59.
! *Mellita Stokesii* A. AG., 1872, Rev. Ech., Pt. I. p. 141.

Pl. XIII^d. f. 1.

Professor Agassiz placed this species in the genus Encope from its exterior appearance, although he pointed out, at the same time, the great differences existing in the internal structure, which is identical with that of Mellita. We find in this species no calcareous wall separating the intestine from the buccal cavity, but only the calcareous network extending from the edge towards the centre, having an identical structure with that of all the

* This is quoted by mistake as *XI^a. f. 3*, p. 320, 4th line from top.

species of Mellita. The mere fact of the lunules remaining open so frequently, the position of the posterior lunule, and the comparatively greater size of the petals are not sufficient grounds, now that we know the changes due to growth in three of the species of Mellita, to separate this species from Mellita and unite it with Encope. We find in M. longifissa, where we have but five lunules, the extreme development of the posterior ambulacral petals so characteristic of the species of Encope. A large series of specimens shows that the closing of the lunules takes place as in Mellita pentapora, and not by perforation as in M. hexapora, to which it is apparently most closely allied.

The outline of this species is more circular than any other of the genus, less truncated posteriorly; the divergence of the petals is quite regularly pentagonal; the petals are of nearly the same length; the odd anterior petal somewhat the longest. The apical system is eccentric posteriorly. The apical system is prominent, with five large genital openings. The posterior opening is less prominent, scarcely perceptible sometimes, and more or less irregular.

The petals are broad, rounded at extremity, which is quite distant from the lunules. The posterior lunule is rounded, placed near the edge, within the inner extremity of the posterior pair of lunules. The ambulacral lunules are frequently open, as in Encope, barely closed, or completely soldered, as in the other species of Mellita.

The actinostome is pentagonal, not central, near posterior edge; anus is pyriform, placed half-way between the edge of the test and mouth. Main ambulacral furrows well marked. Tuberculation of lower surface has general features of Encope. The tubercles of the lateral posterior interambulacra are large, of uniform size, closely packed; those of the other interambulacral spaces are large and distant near the actinostome, but diminish rapidly in size towards the edge, where they are very small and closely crowded together. The tuberculation of the abactinal surface is uniform in size, closely crowded. The spines of the abactinal surface are uniform in size, slender, clavate, cylindrical near the edge, more or less crowded according to the tuberculation; while on the lower side they are larger and stouter in the median interambulacral and ambulacral spaces. The small actinal tubercles of both areas carry minute spines, resembling those of the upper side, more slender, however, and less clavate. Greatest width of the test slightly behind the central transverse axis. Dried specimens are greenish-brown; in alcohol more olive-colored.

Long. Diam.	Trans. Diam.	Dist. Apex Post. Edge.	Post. Lunule from Edge.	Anus from Edge.	Dist. Actin. Post. Edge.	Length Lunules Ant. Pair.	Length Petals Post. Pair
50.	51.	23.	2.	11.2	22.5	9.	12.2

Guayaquil; Panama.

Mellita testudinata

! **Mellita testudinata** KLEIN, 1734, Nat. Disp. Ech.

(See Part II. p. 322.)

Pl. XI. f. 13–22; Pl. XIIa.; Pl. XIIc. f. 1–2; Pl. XXXVII. f. 1, 2.

Brazil; West India Islands; North and South Carolina.

(MELLITA.) ASTRICLYPEUS.

Astriclypeus VERRILL, 1867, Notes on Rad., p. 311.

This genus was first established by Verrill, and shortly afterwards by Troschel, for a sea-urchin, combining at first glance the features of several of the Scutellidae, but which I am inclined, after an examination of the internal structure, to associate with Mellita as a subgenus. It forms the passage between the Scutellidae of the type of Mellita and of the type of Echinodiscus. It has, as in Mellita hexapora, five ambulacral lunules; but no posterior interambulacral lunule, which is found in all the species of Mellita thus far known. It has the same general system of marginal limestone supports existing in Mellita, but has not, like Mellita, the isolated pillars separating the jaws from the rest of the chamber containing the alimentary canal. The whole lower floor is smooth or nearly so, as in some species of Echinodiscus, without pillars, between the inner edge of the marginal limestone network and the auricles. The auricles are low, completely disconnected, with a notch in the centre, much as we find it in Mellita Stokesii. The jaws are identical in structure with those of Echinodiscus; their flatness is extreme; they have, as in that genus, the peculiar pits, articulating them upon the auricles, which are covered by the jaws, and do not hold them in place as in Mellita proper. The teeth themselves are short, flat. This genus is specially important, as connecting most closely the Encopidae with the Scutellidae of the type of Mellita and of Echinodiscus, which seemed, up to the time of the discovery of this genus, widely separated.

Astriclypeus Manni

! **Astriclypeus Manni** VERRILL, 1867, Notes Rad. p. 311.

Pl. XIII^d. f. 2 4.

The test is extremely stout; the outline from above is circular, somewhat truncated on the posterior edge. The test is depressed, regularly conical, with rounded apex, sloping uniformly from the vertex to the thin edge; the vertex is slightly anterior to the apical system, which is large, as in Encope, with the two posterior genital pores farther apart than the anterior. The petals are slightly unequal; the odd anterior is the longest; the anterior pair are only slightly longer than the posterior, and the interporiferous spaces of nearly the same width; the poriferous zones are broad, broadest at the extremity of the petals, which appear abruptly truncated; the petals are nearly closed at the extremity; the inner pore is large, round, connected by a sharp furrow with the minute outer pore; the furrows are in close proximity; the poriferous zones are not so broad as the interporiferous spaces. In large specimens measuring $121^{mm.}$, long. diam., the lunules are oblong, wide; the posterior pair slightly larger than the others. In smaller specimens the lunules were proportionally longer, much narrower, and the difference in length between the odd anterior petal and the anterior pair quite marked; they, in turn, being considerably longer than the posterior pair. The summit of the test was also more conical, not flattened, as in the largest and oldest specimens examined. The lower surface is flat; the actinostome rather nearer the posterior edge than the anterior edge. Shallow grooves extend from the lunules to the actinostome; they carry larger tubercles than those on the rest of the actinal side; similar tubercles also exist round the anal opening, which is smaller than the mouth, of irregular outline, about half-way between the posterior edge and the mouth. The ambulacral furrow, after diverging, runs nearly parallel on both sides of the lunules, sending out from four to five branches, which in their turn send off a few irregular spokes into the broad interambulacral spaces. The actinal surface, except as mentioned above, is covered by a very uniform tuberculation, slightly more crowded in the median interambulacra towards the edge of the test, similar to the tuberculation of the abactinal part of the test, which extends also over the whole of the ambulacral rosette.

On some of the specimens preserved in the Liverpool Museum the spines were still retained on the upper side; they are extremely clavate at the extremity; on the lower side, according to the size of the tuberculation,

they are more or less longer and less clavate. The spines of the median lateral interambulacral spaces point towards the actinostome, while those of the ambulacra and posterior interambulacrum point towards the edge; the reverse is the case in Mellita. The coloration was of a uniform light reddish-yellow.

We owe to Mr. W. H. Dall the first discovery of the locality of this interesting genus; he collected specimens in Japan, and in the Bulletin of the Museum the species was excluded from the geographical lists of the Pacific shores of America. Dr. Martens had also collected it previously in Japan, but supposed it to be a tertiary fossil, till his attention was called to it by the papers of Verrill and Troschel.

Long Diam.	Trans. Diam.	Length Odd Petal.	Length Post Pair Amb.	Width Porif Zone.	Interp. Zone.	Length Lunule Post. Pair.	Dist. Post. Genit Openings.	Dist Anus from Post Edge.
121.	118.		29.	5.6	5.4	18.8	10.	25.
89.	87.	17.3	15.	3.3	3.5	17.	5.5	25.

China; Japan.

ROTULA.

Rotula KLEIN, 1734, Nat Disp. Echin.

Test exceedingly flat; outline circular; anal extremity digitate or deeply lobed. Actinostome small, central; anus nearer the mouth than the edge. Ambulacral petals small, with a tendency to diverge; pores extend as far as the edge. On the actinal surface the ambulacral furrows are studded with small pores; furrows only branching twice, thus forming one branch for each digitation of the margin. The structure of the abactinal system is unique among Clypeastroids; the whole system is raised, forming a prominent star-shaped body, the points and ridges corresponding to the ambulacral system. The four genital openings are placed in the centre of the sides of the abactinal pentagon; the ocular plates occupying the apex. The reverse is the case in all other Scutellidae. The madreporic body is comparatively small. The edge is supported by clusters of radiating partitions, extending but a very short distance towards the centre. The median part of the interior surface of the lower part of the test is smooth; the marginal notches correspond mainly to the interambulacral spaces, there being but one cut in the median ambulacra, except in the odd ambulacrum. The jaws are short, with calcareous lamellae on the two sides; those of the upper edge much larger

than those of the lower side. The furrow in which the teeth are articulated is deep; the teeth are thin, sharp, as in Mellita. The auricles are thin, broad, and flat, scarcely rising above the lower floor; the edges form a small furrow, corresponding to a sharp ridge on the lower surface of the jaws.

D'Orbigny and Desor have proposed to separate Rotula into two genera. I do not think this distinction is warranted. The marginal cuts, except the two corresponding to the extremity of the lateral ambulacra, are simple marginal notches, which we know, from the mode of development of similar notches in Encope, to be subject to great variation, and the presence of two additional closed anterior interambulacral lunules in R. Augusti is not a sufficient reason for separating it generically from R. Rumphii; there is certainly nothing in the interior structure of the test warranting the separation proposed by D'Orbigny, and adopted by Desor.

Rotula Augusti

!**Rotula Augusti** Klein, 1734, Nat. Disp. Ech.

Pl. XIII^c. f. 4–5; Pl. XXXIII. f. 5.

The outline of the test is rounded anteriorly, somewhat truncated posteriorly, though in young specimens the general outline is almost circular. The test is depressed; vertex anterior to the apical system, which is rather eccentric posteriorly. There has been great confusion introduced in the nomenclature of this species, from descriptions made upon specimens of different sizes, which vary greatly in the number, size, and proportions of the marginal cuts. The general character of the marginal cuts is, that we have five deep median interambulacral cuts extending half-way towards the centre; the principal lobes thus formed are again subdivided along the posterior edge, so as to form two to four digitations in the posterior lateral and the odd interambulacral spaces, — one or two on each side of the original median cut; while in the anterior lateral interambulacral spaces the median cuts become narrower with advancing size, and eventually close, so as to form lunules in the interambulacral spaces. The median cuts opposite the anterior lateral ambulacra also close as lunules with advancing age. The digitations are broad, rounded at the extremity, and with sides of variable size; the two adjoining the median interambulacral line have one side much the longest, while those forming the central part of the lobe have shorter sides of nearly equal length. From an examination of a very young specimen we see that the

digitations are formed without exception as marginal cuts, forming at first mere indentations of the outline of the nearly circular test. The three posterior median interambulacral notches are the first to appear. Subsequently the two anterior interambulacral cuts appear (first on the lower side), and the median ambulacral cuts of the posterior pair of ambulacra much as they are formed in Encope.

The petals are long, narrow, open at the extremity; the interporiferous space is of uniform width, broadest in the odd petal, and narrowest in the posterior lateral pair of petals. The poriferous zones are broad in old specimens, broader than the median space; the poriferous zones extend as isolated pairs of pores nearly to the edge of the test. In large specimens, measuring from 60$^{mm.}$ to 70^{mm}, the structure of the poriferous zones becomes peculiar. The inner row of pores is the largest in young specimens, and is united to the outer row of smaller pores by an indistinct groove. In the larger specimens this indistinct furrow is completely pitted, for the outer part of its length, by small pores, nearly as large as the outer pore, extending from the outer pore to within a short distance of the inner row of pores (about one third the width of the poriferous zone); this structure is well figured by Agassiz in his Monographie des Scutelles, but is not referred to in the text. It gives to the petals a peculiar aspect, the poriferous zones appearing, as it were, to be formed of narrow, sharply cut lines, commencing at a distance from the inner row of pores, and extending to a minute outer row of pores.

The tuberculation of the abactinal surface is homogeneous; the spaces between the primary perforated and crenulated tubercles are closely packed by miliaries. The apical system is small, compact, pentagonal, with four large genital openings in the middle of the anterior sides of the pentagon. There are irregular ridges running to the apex and centre of the sides of the apical system, which are not riddled by the holes of the madreporic body. The ocular pores are small, placed at the outer angles of the apical system. The whole system is raised above the level of the abactinal part of the test, standing out prominently from the apical extremity of the petals.

On the actinal side the tuberculation is coarser; the tubercles adjoining the ambulacral furrows are small, and the miliaries are more distant and less numerous than on the abactinal surface. The mouth is small, circular; the ambulacral furrows deep, separating into two branches immediately near the mouth, and forking again about half-way towards the edge, so as to send one branch into each digitation of the margin of the test. The anus is rather

nearer the mouth than the edge; it is transversely elliptical, larger than the mouth, with slightly raised edges. The anal plates and spines of the two surfaces were not preserved in any of the specimens I have had occasion to examine.

Liberia.

Rotula Rumphii

! **Rotula Rumphii** KLEIN, 1734, Nat. Disp. Ech.

Pl. XIII^c. f. 6–7.

This species is readily separated from its congener by the nature of the digitation of the posterior edge. The outline of the test is circular, pointed anteriorly. The greatest diameter is the longitudinal diameter, which is slightly greater than the transverse. The opposite is the case in R. Augusti. The edge of the test is thin, the central part higher; the petals arching regularly from their extremity to the apex. The vertex is anterior, but closer to the apical system, which is almost central. The petals are small; do not extend so far towards the edge as in R. Augusti; they are lanceolate, pointed, with a tendency in the poriferous zones to approach towards the extremity; the poriferous zones are much narrower than the median interporiferous areas. The interporiferous space is greatest in the odd anterior petal, and the same in the lateral petals; the posterior petals are shorter than the anterior pair; they, in turn, are shorter than the odd petal. In none of the largest specimens examined do we find more than one or two of the pores in the furrows connecting the outer and inner row of pores so markedly developed in R. Augusti. The inner pore is the largest in this species. The abactinal system is comparatively larger, less pointed; but the position of the ocular and genital pores is the same; the apical system is more conical, and still better isolated from the abactinal extremity of the petals than in R. Augusti; as in R. Augusti the petals are slightly swollen in the central interporiferous part near the apex, while the median space, as well as the whole of the petal, is flush with the surface of the test in R. Rumphii.

The digitations of the posterior edge of the test vary greatly with age; they are entirely confined to the posterior interambulacral spaces; the anterior pair of ambulacral notches and the anterior interambulacral lunules of R. Augusti exist only as slight indentations. The notches extend only somewhat more than one third the distance from the edge in the median odd

posterior interambulacral space, where the digitations are longest, gradually diminishing in size towards the anterior lateral ambulacra, where they are reduced to mere indentations. The digitations are longest in the prolongation of the two inner sides of the posterior ambulacra; the two median interambulacral ones corresponding to the odd interambulacral space are usually slightly shorter. The mode of formation and order of appearance of the digitations appear identical with that described in R. Augusti; in very small specimens we find on the edge, seen from the lower side, traces of the three posterior median interambulacral notches.

The tuberculation of the abactinal surface is closer than in R. Augusti; the miliaries are less numerous, and on the actinal surface, though the tubercles are larger, there is by no means so striking a contrast in the tuberculation of the two sides. The actinostome is small; the anal system nearly circular, smaller than the mouth; the furrows are less deep and less marked than in R. Augusti, but branch very much as in that species.

Though the specimens of R. Rumphii to which I have had access had lost their spines, they were not so completely bleached as those of R. Augusti, and retained their color to a certain extent. They were of a bluish-green on the upper side; the lower of a lighter green, mottled with yellow, along the furrows and sutures.

Senegal; Cade Verde Islands.

ENCOPE.

Encope AGASS., 1840, Cat. Syst. Etyp.
(See Part II. p. 324.)

Encope californica

! *Encope* **californica** VERRILL, 1870, Sill. Jour., p. 97.

This species and Encope grandis represent on the west coast Encope Michelini; it has, like Encope Michelini, its vertex immediately anterior to the interambulacral lunule. The outline is rounded anteriorly; the greatest diameter half-way between the apex and the posterior edge; the posterior edge is frequently somewhat rounded or truncated. The apical system is nearly central. The petals are regularly elongate, rounded anteriorly; the anterior pair is the shortest, with proportionally widest interporiferous space. The posterior pair are longer than the odd petal, and are not curved.

The interporiferous space in the anterior and posterior petals is nearly of the same width. The poriferous zones are broad, broader than the enclosed area in the posterior and odd petals. The interambulacral lunule is small, though longer than the ambulacral ones, and very variable in shape. The ambulacral lunules are pretty regularly oval; the odd anterior the smallest; the anterior pair next in size, and the posterior the largest; in all the specimens I have seen, they show traces of their mode of formation as marginal cuts, and they are often at a considerable distance from the edge of the test. The internal structure, when compared to one of the other western species, E. micropora, shows a corresponding difference (in the size of the jaws, the dimensions of the walls separating the alimentary canal from the actinal cavity), similar to what has already been alluded to and figured between E. emarginata and E. Michelini.

This species differs very materially from E. Michelini, in the first place by the relatively much smaller size of the ambulacral petals, which reach a great size in E. Michelini, in the presence, almost universal, of ambulacral lunules; and, in the second place, on the actinal side by the position of the anus, and the comparatively larger space enclosed in the broad bulging branches of the ambulacral furrows, which merely diverge from their origin in E. Michelini, and run more parallel towards the edge of the test.

Gulf of California.

Encope emarginata

Echinodiscus **emarginatus** LESKE, 1778, Kl. Add., p. 136.
! *Encope emarginata* AGASS., 1841, Mon. Scut., p. 47, *Pl. X.*
(See Part II. p. 325.)

Pl. XII. f. 14–24; Pl. XII^b. f. 1–3; Pl. XII^d. f. 2–3.

Brazil; West Indies.

Encope grandis

! **Encope grandis** AGASS., 1840, Cat. Syst. Etyp.

Pl. XIII^d. f. 5–6.

The origin of this interesting species was not known till General Stone sent some specimens from Guyamas and from other points of the Gulf of California to Professor Agassiz, a short time previous to the publication of the Exchange List of Echini in the Museum Bulletin for 1863. Subsequently it was found again by Captain Pedersen, who sent numerous specimens to the Yale College Museum. It is remarkable for the solidity of the test, the

stout thick edge, the immense size of the posterior interambulacral lunule, with its thick raised edge, which occupies the greater part of the posterior interambulacral space, and the broadly open shallow ambulacral notches. I have not, in the specimens examined, found any of these notches showing a tendency to close. The posterior cuts are the largest; the anterior pair somewhat smaller; and the odd ambulacral cut is sometimes a mere indentation. The apical system is large; the genital openings distant. The posterior ambulacral petals longest, arched outwardly, with a narrow interporiferous space; poriferous zones broad; the median space in the anterior petals as broad as the poriferous zones. The general outline is pentagonal; posterior edge concave, or straighter than the other interambulacral sides. The apical system is anterior; the vertex posterior, at the anterior extremity of the interambulacral lunule.

The furrows of the actinal side are remarkably deep, and commence to branch a short distance from the mouth; they are more diverging and less arched than the furrows generally in Encope. The anus is situated at the anterior extremity of the lunule, about one quarter the distance from the mouth to the edge of the test. The median ambulacral spaces are quite sunken on the lower side, forming a shallow, somewhat branching groove from the marginal cuts towards the actinostome. The general coloration of dried specimens is dark-greenish with a claret tinge; on the lower surface the median ambulacral and interambulacral spaces are yellowish. The spines of the two surfaces differ, as in all Encopidae; they are short, of uniform size, clavate on the abactinal side, and larger, stouter, and more fluted and cylindrical on the actinal side in proportion to the size of the actinal tubercles.

The jaws, as in the species of Encope in which the posterior lunule is large, or the anus placed near the actinostome, are comparatively small; they are quite slender in this species, and much less powerful than in Encopidae of the same size.

Long. Diam.	Trans. Diam.	Dist. Apical Syst. from Ant. Edge.	Length Ant. Pair Petals.	Width Porif. Zone	Interp. Zone.	Dist. Anus from Mouth.	Dist. Mouth Ant. Edge.	Length Interamb. Lunule.
115.	116.	52.	30.	5.	6.	9.	55.	29.5
108.	111.	45.	28.	4.9	5.	7.	47.	27.
93.	95.	42.	27.	4.8	4.8	10.	42.2	24.
85.	89.	37.5	24.			8.	39.5	18.

Gulf of California.

Encope Michelini

! *Encope* **Michelini** AGASS., 1841, Mon. Scut, p. 58.
(See Part II. p. 329.)

Pl. XII^b. f. 4; Pl. XII^c. f. 3–4; Pl. XII^d. f. 1.

Yucatan; Florida.

Encope micropora

! *Encope* **micropora** AGASS., 1841, Mon. Scut. p. 50.

This is the Pacific representative of Encope emarginata. Although the species of Encope vary to an extraordinary extent on the Atlantic side of the coast of North and South America, we find a much greater uniformity in the general appearance of the species found on the west coast of this continent.

We find neither in E. grandis, E. californica, or E. micropora, such a range of variation as we have described in E. emarginata, and which has led to the discrimination of so many false species. This species is readily separated from E. emarginata. The test is depressed; vertex anterior, near the extremity of the odd ambulacrum. The outline is rounded anteriorly, truncated posteriorly; apical system small; posterior interambulacral lunule small, round, or elliptical nearer the edge than the apex. The petals are comparatively longer than in E. emarginata, extending towards the margin, so as to leave room for only small elliptical ambulacral lunules. The interporiferous space of the petals is broad, as broad as the poriferous zones; the pores are more closely crowded than in the corresponding Atlantic species. The actinostome is central; the anus is placed half-way between the mouth and the interambulacral lunule.

The interambulacral spaces left between the ambulacral furrows are smaller than those in E. emarginata, owing to the greater spread of the furrows towards the ambulacral lunules. On examining the interior we find very striking differences between E. emarginata and this species. In E. micropora we have the relatively smaller size of the jaws, the great width of the walls separating the convolutions of the alimentary canal, the walls being in some places more than equal in width to the size of the alimentary canal; while in E. emarginata the walls are narrow, scarcely equalling more than half the width of the alimentary canal. In larger specimens the comparative length of the petals is not increased; the edge of the test seems to increase in width, and we find a greater distance between the extremity of

the petals and the ambulacral lunules. The color, so far as can be judged from dried specimens, does not differ from that of E. emarginata.

Long. Diam.	Dist. Apical Syst. Ant Edge.	Length Post. Pair Petals.	Width Porif. Zone Post. Pair	Width Interporif Zone.	Dist. Mouth from Anus.
92.	49.	29.1	4.3	5.2	10.
122.	63.	33.	5.	8.	12.5

Panama ; Gulf of California.

PETALOSTICHA.

Suborder **Petalosticha** Haeckel, 1866, Generelle Morphol. (emend.)

This third suborder contains Echini in which the ambulacra are more or less petaloid, without teeth, and in which the anal system is, as in the Clypeastroids, disconnected from the apical system. The anterior and posterior extremity are plainly characterized, not only by the shape of the test, but also sometimes by the structure of the odd ambulacrum. The subfamilies here recognized in this suborder are more easily characterized than the common features of the families, which, with the exception of the few ordinal features mentioned above, seem to be more negative than positive.

In this suborder we find specializations of certain parts of the test and spines carried out to a greater degree than in the other suborders; the presence of plastrons and of fascioles, which are accumulations of miliary tubercles in certain lines, are characteristic of most of the genera of Spatangoids.

CASSIDULIDAE.

Family **Cassidulidae** Agass., 1847, C. R. Ann. Sc. Nat. VII. 147.

They differ from the Clypeastroids by the absence of teeth, and less distinct structure of the apical system; ambulacra more or less petaloid. Mouth pentagonal, oblique, or elliptical, central or subcentral; in some genera the pores round the actinostome are connected by furrows and form elegant designs, to which the name of phyllodes has been given. These phyllodes are separated by clusters or knobs of tubercles, rising in the interambulacral spaces between them, known as bourrelets; the phyllodes with the bourrelets form the floscelle. We have included in the Cassidulidae, as here limited, only genera which have no plastrons or fascioles. The tubercles are neither perforate nor crenulate, as they are in Clypeastroids. Position of anal system variable.

ECHINONIDAE.

Subfamily **Echinonidae** AGASS., 1847, C. R. Ann. Sc. Nat., VII. 147.
(See Part II. p. 332.)

ECHINONËUS.

Echinonëus VAN PHELS., 1774, Brief.
(See Part II. p. 332.)

Echinonëus cyclostomus

Echinoneus **cyclostomus** LESKE, 1778, KL. Add., p. 173.

Pl. XIV. f. 6–8 ; Pl. XIV^{a}*. f. 5–10.*

A large, denuded specimen, measuring one and a half inches in its longest diameter, was of a dark brown color; the poriferous zones extending along the test as darker narrow lines, and the primary tubercles being prominent by their yellow color. In this specimen the anal and buccal membranes were preserved entire. The buccal membrane was entirely paved by small, irregularly shaped plates, covering the whole surface, and leaving but a small opening in the centre, — the elliptical mouth; the plates diminished in size towards the oral opening; there were no less than twenty-six plates in the circle adjoining the test. Covering the anal membrane, there were four large plates extending on each side of the pear-shaped anus, the rest of the membrane being covered with smaller plates; the anus was placed near the blunt (posterior) extremity of the anal opening. For a comparison between the two species of Echinonëus see Part II. p. 333.

Australia; Kingsmills Islands; Zanzibar.

Echinonëus semilunaris

Echinus **semilunaris** GMEL., 1788, LINN. Syst. Nat.
! *Echinoneus semilunaris* LAMK., 1816, An. s. Vert., p. 19.
(See Part II. p. 333.)

Pl. XIV. f. 1–5; Pl. XXXVIII. f. 26.

Florida; West India Islands.

NUCLEOLIDAE.

Subfamily **Nucleolidae** AGASS., 1847, C. R. Ann. Sc. Nat., VII. 147.

The ambulacral petals are petaloid or subpetaloid. The odd ambulacrum not different from the lateral ambulacra. Actinostome pentagonal, its sides on one level, with prominent bourrelets and well-developed phyllodes.

NEOLAMPAS.

Neolampas A. AG., 1869, Bull. M. C. Z., I.
(See Part II. p. 340.)

Neolampas rostellata

! **Neolampas rostellatus** A. AG., 1869, Bull. M. C. Z., I. No. 9, p. 271.
(See Part II. p. 340.)

Pl. XVII. f. 1–12.

Straits of Florida.

ECHINOLAMPAS.

Echinolampas GRAY, 1825, Ann. Phil.
(See Part II. p. 335.)

Echinolampas depressa

! *Echinolampas* **depressus** GRAY, 1851, Ann. Mag. N. H., p. 38.
(See Part II. p. 335.)

Pl. XVI.

The specimens of this species in the British Museum were readily distinguished from E. oviformis by the large, elliptical actinostome, more central, deeply sunken; floscelle not flush, as in E. oviformis, with indistinct bourrelets. The anal system is large, elliptical, elongated, with the test projecting posteriorly more than in E. oviformis. Outline of test posteriorly convex. Tubercles larger than in E. oviformis. In the unequally developed petals the posterior zones of the posterior petals are the shortest, the anterior zones in the anterior petals, and the left odd anterior zone. The pores of the inner and outer zones are of the same size.

Straits of Florida.

Echinolampas Hellei

Echinolampas Richardi (**Desml.**), 1837 Tab. Syn., p. 340. (non DESMT.)

! *Echinolampas* **Hellei** VAL., 1869, in PERR. Pédic., p. 170.

Pl. XV. f. 5–11; Pl. XV^a. f. 5–6.

This species is readily distinguished from its Indian congener by the more central position of the apical system, the greater equality in the development of the anterior and posterior poriferous zones of each petal, the close arrangement of the pores of the narrow poriferous zones, the great size of the apical system, and more distant tuberculation. The test is depressed, and the outline from above quite angular, rounded anteriorly, and slightly truncated posteriorly, somewhat resembling, at first glance, species of Clypeus. Alcoholic specimens in the Jardin des Plantes show that the spines are short and of uniform size, of a dark violet color, — brown, according to Desmoulins. Actinal surface concave; edges of test swollen, sloping towards the actinostome. Phyllodes and bourrelets very prominently developed, when compared with those of several other fossil species of the genus. The anus in all species of Echinolampas is inframarginal, flush with the actinal surface of the test; anterior edge of anal system slightly curved in; tuberculation closest immediately at the ambitus; somewhat less close, but uniform over the actinal surface, and gradually more distant towards the actinostome.

Considerable confusion has arisen, in the discrimination of this species, from its identification with a fossil species by Desmoulins; he, however, subsequently separated them, and lately has given an excellent figure of the African Echinolampas in the Actes de la Soc. Linn. de Bordeaux.

I have figured, in *Pl. XV. f. 7*, the anal system of this species of Echinolampas; the general mode of arrangement differs materially from that of Rhynchopygus. There is one large anterior row of four plates, covering almost the whole membrane, with large tubercles; the rest of the membrane is strengthened by carrying from six to seven minute plates, in the centre of which is situated, near the posterior edge, the small, elliptical anal opening.

It is barely possible that this species and E. depressa may prove identical; we have unfortunately only specimens of such different size existing in our collections that no direct comparison can be made. The principal differences noticed in the ambulacral system may be only due to changes occurring during growth.

Long. Diam.	Trans. Diam.	Height.	Dist. Apical Syst. Ant Edge.	Dist. Actinost. Ant. Edge.	Width Post. Pair Porif. Zone.	Width Post. Pair Interp Space.	Dist. Post. Gen.
88.	79.	41.	36.	34.	1.1	8.	3.4
54.	48.	29.	19.	21.	.9	4.	2.8

Senegal.

Echinolampas oviformis

Echinus **oviformis** GMEL., 1788, LINN. Syst. Nat.
! **Echinolampas** *oviformis* GRAY, 1825, Ann. Phil., p. 7.

Outline from above elliptical; test high, swollen at the edges; apex very eccentric anteriorly; apical system small; poriferous zones broad; pairs of pores distant; petals, especially the posterior pair, but little petaloid; poriferous zones diverging; anterior zones of anterior pair, and posterior zones of posterior pair of petals much shorter than the other zones of the same petals. Tuberculation distant; mouth, in both E. oviformis and E. Hellei, corresponds nearly in position with the position of the apical system. Actinal surface arching gradually towards the actinostome, less concave, except near the actinostome, than in E. Hellei.

Bourrelets scarcely developed, and in old specimens forming a mere thickening of the lip of the actinostome, with phyllodes more or less indistinct. The tuberculation of the actinal surface is coarser than that of the upper part of the test, and more distant near the actinostome than in E. Hellei.

Unfortunately the specimens of Echinolampas preserved in our collections are usually dry tests, and little can be learned from them, excepting from the short comparisons made above.

Long. Diam.	Trans. Diam	Height.	Dist. Apex Ant. Edge.	Dist Actinostome Ant. Edge.	Dist. Post. Gen.	Width Post. Pair Porif. Zone	Width Post. Pair Interp. Space.
71.	63.	47.2	28.	29.	2.	1.6	4.
68.	45.	35.	19.4	22.5	2.5	1.2	4.1

Red Sea; Molucca Islands.

(CASSIDULUS.) RHYNCHOPYGUS.

Rhynchopygus D'ORBIG., 1855, Pal. Franç., VI.
(See Part II. p. 342.)

Rhynchopygus caribaearum

! **Cassidulus caribaearum** LAMK., 1801, An. s. Vert., p. 349.
! *Rhynchopygus caribaearum* LÜTK., 1864, Bid. App., p. 1.
(See Part II. p. 343.)

Pl. XV. f. 1–4; Pl. XXXVII. f. 12.

D'Orbigny established the genus Rhynchopygus for Cassidulus guadeloupensis, a tertiary fossil from Guadeloupe, which is probably identical with the species now found living in the West Indies and Straits of Florida.

West India Islands.

Rhynchopygus pacificus

! *Pygorhynchus* **pacificus** Ag., 1863, Bull. M. C. Z., I. p. 27.
! *Rhynchopygus pacificus* A. Ag., 1872, Rev. Ech., Pt. I. p. 153.

Pl. XV^a f. 1–2; Pl. XXXII. f. 1–10; Pl. XXXIII. f. 1–2.

Outline from above elliptical, angular, rounded anteriorly, somewhat more pointed posteriorly; vertex and apical system coincident, slightly anterior; ambulacral petals lanceolate, extending nearly to the edge, open at the extremity; poriferous zones broad; pores distant; poriferous zones equally developed in all petals, except that the posterior zones of the posterior pair of petals are much shorter than the anterior zones. Apical system small; posterior genital pores somewhat more separated than the anterior pair; madreporic body slightly convex. Seen in profile, the outline is regularly arched to the anterior extremity, and towards the posterior as far as the anal projection of the test, placed about one third the height from the edge to the apex; posterior lip of anal opening depressed; test sloping from it towards the edge, forming at the same time a shallow anal groove. Actinal surface nearly flat, forming a sharp angle with the sides of the test at the ambitus, sloping slightly towards the sunken actinostome; mouth pentagonal, nearer anterior extremity than apical system; anterior bourrelets greatly developed, very prominent; posterior bourrelets smallest, less prominent than odd interambulacral one. Phyllodes large, commencing at a distance from the actinostome, with as many as seven to nine pores on each side in the outer row of pores, standing out prominently in the smooth, dagger-shaped band, extending from the anterior to the posterior edge; this band is broadest in the anterior ambulacrum, forming a continuous star-shaped band round the actinostome, extending a short distance in the lateral ambulacra, slightly beyond the phyllodes, uniting in the median posterior interambulacral space, and gradually tapering (with angular concave sides) towards the posterior edge of the test. The whole of this apparently smooth band is covered by minute distant tubercles, carrying short, slender, silk-like spines, and is irregularly pitted along the lines of the sutures of the plates of the test. The tuberculation of the abactinal surface is quite uniform, extending on the actinal side but a short distance from the ambitus; it then increases rapidly in size; the pits surrounding the tubercles become deeper and broader, attaining their greatest size immediately adjoining the median actinal band. The spines of the abactinal side are short, slender, longitudinally striated, cylindrical, tapering; those of the actinal side more or less curved, especially the larger ones, which resemble more spines of Spatan-

goids proper, but they have the same ornamentation as those of the upper side of the test. The ridges separating the pits round the larger tubercles of the actinal side are irregularly studded with minute tubercles, carrying small spines like those of the median band. Similar tubercles are irregularly scattered on the ridges between the primary tubercles of the upper surface, carrying slender, silk-like miliary spines. The transverse crescent-shaped anal opening is protected by a membrane covered by a posterior row of four large polygonal plates, with a second row of five or six smaller ones, and an irregular minute row at the edge of the membrane next the anal opening; this is an elongated slit placed near the upper part of the anal system, directly under the projecting ridge of the test.

The greatest diameter in smaller specimens is in front of the anus, while in older specimens it is anterior to the apical system. The inner pores of all the poriferous zones are round, joined by a shallow furrow to the outer larger comma-shaped pores, which extend, irregularly scattered, from the termination of the petals towards the actinostome, where they meet the phyllodes.

The color in alcohol is greenish-yellow, mottled with darker spots, but slightly darker than the light greenish-yellow tint, similarly spotted, of life. This species lives like other Spatangoids of which the habits are known,— gregariously on sandy beaches, from five to six feet below low-water mark, half buried in the sand up to the extremity of the petals.

Long. Diam.	Trans. Diam.	Height.	Dist. Apex Ant. Edge.	Diam. Anal Syst.	Width Porif. Zone Ant. Pair.	Width Interp. Space Ant Pair.	Dist. Mouth Ant. Edge	Diam. Mouth.
54.	45.5	31.	23.	8.1	1.5	4.	17.5	6.3
49.1	41.2	25.	20.8	8.1	1.1	3.	16.3	5.2
41.5	35.	20.9	17.5	7.5	1.	2.1	14.	

Galapagos; Panama; Gulf of California.

ECHINOBRISSUS.

Echinobrissus BREYN., 1732, Schediasm. de Echin. (pars.)

Test rather flat, elongate, subquadrate, wider at posterior extremity, more or less convex above, concave below. Ambulacral petals somewhat lanceolate; poriferous zones narrow; pores not conjugate. Vertex eccen-

tric; anal system placed in a more or less sunken furrow. Actinal system eccentric, pentagonal, or transversely elliptical. Floscelle rudimentary; no well-marked bourrelets.

Echinobrissus recens

! *Nucleolites* **recens** Edw. 1836, Cuv. Règn. An. Ed. Ill.
! *Echinobrissus recens* D'Orbig., 1854, Rev. Mag. Zool., p. 24.

Pl. XIV^a. f. 2–4; Pl. XXI^b. f. 1–2; Pl. XXXVIII. f. 30–31.

Test stout, depressed; outline from above somewhat rectangular, rounded anteriorly; greatest breadth across the posterior extremity of the posterior petals, angular posteriorly; posterior edge scarcely indented by anal furrow. Vertex nearly central; apical system anterior to vertex; anterior petals extending nearly to the edge of the test; posterior pair reaching somewhat more than half the distance from the apex to the posterior edge. Poriferous zones of uniform breadth, diverging slightly, so as to leave the extremity of the petals somewhat open; pores of both zones round, of uniform size, irregularly conjugated; outer rows extending to the actinostome from the extremity of the petals; interporiferous spaces broader than the poriferous zones, broadest in the anterior petal. Petals flush with the test, posterior pair the longest; four genital pores, posterior scarcely more distant than the anterior pair. Anal furrow reaching vertex; anal opening longitudinally elliptical; posterior edge nearly on a level with the edge of the test; sides of groove very gradually rounded. In one of the specimens of the Jardin des Plantes the anal membrane is well preserved (*Pl. XIV^a. f. 2, 3*); there is a large outer row of plates round the posterior edge, with smaller ones extending towards the nearly circular anal opening, situated at the top of the anal system; the plates immediately round the anal opening are small, closely but irregularly packed, becoming somewhat larger again, near the upper part of the anal system. The continuation of the petals towards the actinostome is well seen in *Pl. XIV^a. f. 3, 4*, — interior views of the test.

The tuberculation is large; the tubercles more closely packed on the central part of the plates; on the edges near the sutures the miliaries are more numerous, forming indistinct, irregularly shaped lozenge figures, parallel with the longitudinal sutures of the plates. The tuberculation of the anal furrow is reduced to miliary granulation. On the lower surface the tubercles are distant in the posterior interambulacral space, but closely crowded in the swollen edge of the posterior interambulacra. The actinostome is sunken;

the actinal surface is regularly concave, arching towards the mouth from the rounded edge; the posterior part of the transversely elliptical mouth is on a lower level than the anterior lip, — the first trace we have found of the projecting lip, so highly developed in Spatangoids, a character used at one time to distinguish the Cassiduloids from the Spatangoids proper. The continuation of the outer poriferous zones is quite distinct from the edge to the actinostome, running gradually into the phyllodes, which are simply diverging lines of pores from the actinostome. The tuberculation of the interambulacra at the actinostome is small, it consists of primary tubercles closely crowded, but in all specimens examined no buccal bourrelet had been developed.

The spines are still preserved on the specimen originally figured by Milne-Edwards for the illustrated edition of Cuvier's Règne Animal. They are short, stout, resembling in their general structure the spines of Echinolampas, as we know them from those of Echinolampas depressa figured in Part II. of this Revision, and of E. Hellei, of which alcoholic specimens are preserved in the Jardin des Plantes.

The general coloration of dried specimens was yellowish-brown; the test somewhat darker where the tubercles are more closely set; and the spines mottled with dark and light brown, usually tipped with the lighter tint.

New Zealand; Madagascar.

(ECHINOBRISSUS.) Nucleolites.

Nucleolites Lamk., 1801, An. s. Vert. (pars.)

I have retained provisionally the separation into two genera of Echinobrissus proposed by Desor and D'Orbigny, though, from the examination of the scanty material of living species, the splitting into two sections of this genus seems scarcely warranted; the mere conjugation of the pores is an insufficient character, as in specimens of N. epigonus and of E. recens we find in the same individual a petal in which the conjugation is marked, another where it is indistinct, and frequently the corresponding one in which the conjugation cannot be traced. Limited as the genus Echinobrissus is here, I have taken as type of the genus, Echinobrissus recens, and as the type of one subgenus of it, Nucleolites epigonus; subsequent observations will, I have no

doubt, prove these genera to be identical. In the subgenus represented by epigonus, the actinostome is longitudinally elliptical, while it is transversely elliptical in E. recens. In one subgenus the posterior extremity is vertically truncated; in the other the outline of the test is nearly uniformly arched from the anterior to the posterior extremity; neither of these characters seem to justify us in retaining permanently the genera Echinobrissus and Nucleolites; they are however retained, in order not to introduce new complications from insufficient data, as neither of these species correspond exactly to the genera Nucleolites and Echinobrissus, as recognized by Desor and Cotteau, from the study of the fossil species, where considerable confusion still exists. Wright does not admit the distinction made by Desor, D'Orbigny, and Cotteau, and Forbes united Clypeus with Echinobrissus as a subgenus, showing that the classification of this group is by no means satisfactory as deduced from the examination of the fossil species alone.

Nucleolites epigonus

! *Nucleolites* **epigonus** MART., 1865, Monatsb. Akad. Berlin, März, p. 143.

Pl. XIX^b. f. 4–6.

Test thin; outline from above elliptical, rounded anteriorly, attaining its greatest breadth opposite the posterior extremity of the posterior lateral ambulacra; truncated across the posterior ambulacra; median interambulacrum indented by a deep vertical anal groove. Lower side concave, sloping rapidly from the swollen, bulging, lateral interambulacral edge to the large actinostome, which is anterior, longitudinally elliptical.

The outline in profile is regularly arched, falling towards the anterior extremity from the nearly vertically truncated posterior edge; the vertex is placed immediately anterior to the deep anal groove; the anal system is longitudinally elliptical, placed at the bottom of the groove; the edges of the groove are sharp near the upper end, but gradually become rounded towards the actinal surface; apical system anterior; madreporic body flush with the test; four large genital openings. The petals are of nearly uniform width, and equally developed; the posterior pair extending somewhat beyond half the distance between the apical system and the edge; they are slightly larger than the others. The other petals extend to within a short distance from the edge; the median interporiferous zone is broadest in the odd anterior petal, and narrowest in the posterior pair; from the extremity of the

petals the outer poriferous zones extend to the actinostome as independent disconnected pores till they reach the phyllodes, when the pores become again large, and arranged in two irregular rows diverging from the actinostome. The ambulacral petals are narrow, elongate, flush with the test; the poriferous zones are as broad as the median interporiferous space; the pores are round, large, distinct; outer row the largest, connected by a shallow furrow. The median odd posterior interambulacral line forms an indistinct rounded keel from the vertex to the apical system. The tuberculation is uniform over the whole abactinal surface, closely crowded with large miliaries, mounted on the ridges separating the pits in which the tubercles are placed. In the anal groove the tuberculation is reduced to a mere granulation; on the actinal surface the tubercles are more distant, the miliaries between them less crowded. The steep sloping sides of the actinostome are covered with closely packed uniform miliaries, barely forming traces of bourrelets on the upper edges. None of the specimens of this interesting species, either in the Berlin, London, or Stockholm Museums, had retained their spines; they were merely bleached tests, like the one figured in *Pl. XIX*^{b}.

East India Islands.

(ECHINOBRISSUS.) Anochanus.

Anochanus Grube, 1868, Monatsb. Akad. Berlin, March, p. 178.

This subgenus is retained for a remarkable sea-urchin, with which future investigations must make us more familiar before we can decide its generic affinities. The test resembles in outline Echinobrissus; has the same anal groove; the ambulacra, according to Grube, run uninterruptedly from the apex to the actinostome. The apical system is wanting, and is replaced by an opening leading into a genital cavity which does not communicate with the interior of the test, and in which the young are found. This abnormal mode of development in sea-urchins seems to correspond to the viviparous mode of development of some Ophiurans and Starfishes, in which the Pluteus is never pelagic; but we must await the publication of Grube's memoir for further information regarding the single species of this genus thus far found.

Anochanus sinensis

! **Anochanus sinensis** Grube, 1868, Monatsb. Akad. Berlin, March, p. 178.

Grube does not give a detailed description of this remarkable sea-urchin, only saying that it resembles Nucleolites epigonus. From a cursory examination of the specimen it seems more closely allied to Echinobrissus recens, and is of about the same size. The young found in the breeding sac are circular, the actinostome is central, while it is eccentric anteriorly, and transversely elliptical in the adult; the primary spines are arranged in two principal rows upon the interambulacra; they have no apical breeding-sac nor anal furrow, though what appears to be the anal opening is found above the ambitus, somewhat behind the vertex. Grube says that the inner walls of the breeding sac are lined with pedicellariæ; larger pedicellariæ are found upon the abactinal part of the test; the spines are arranged without any apparent order, and are of two kinds, — longer ones rather blunt, and shorter ones spreading into a serrate extremity. There appears at the bottom of the sac a plate leading into a stiff canal, which may denote the position of the madreporic body; but no trace of genital openings or of ovaries could be detected. The breeding sac is filled with a membrane strengthened by a limestone network, suspended from the inturned edges of the opening of the sac on the abactinal surface. The greater part of the inner cavity of the test is occupied by the large digestive canal, commencing with a narrow œsophagus; at the junction of the œsophagus with the stomach are found two small diverticula. The young appear, according to Grube, to develop on the lower side of the breeding cavity, where they are enclosed by a small sac. It is supposed that this sea-urchin came from the China Seas or East India Islands.

East India Islands.

SPATANGIDAE.

Family **Spatangidae** AGASS., 1836,* Prod. Mon. Rad. (emend.)

In this family the actinal part of the test is occupied by a plastron, the sides of which are well defined by bare ambulacral avenues. The posterior ambulacra towards the posterior extremity are frequently divided by a fasciole, running in such a way as to separate the two poriferous zones and form a limited area (subanal plastron) or plastron, which may or may not be closed, and is more or less distinct. Other plastrons are formed by the fascioles consisting of a crowded pavement of miliary tubercles carrying miliary spines, running either within the petals (internal), or round the petals (peripetalous), from which sometimes branches are sent off towards the anal extremity (lateral). When the sub-anal fasciole sends a branch round the anal system it forms the anal fasciole; the lateral becomes the anal fasciole when it runs continuously below the anal system, round the posterior extremity of the test. The combination of these fascioles together with the shape of the test and of the petals has been made the most important element in the subdivisions into subfamilies of the Spatangidae.

ANANCHYTIDAE.

Subfamily **Ananchytidae** ALB. GRAS, 1848, Éch. foss. Isère.
(See Part II. p. 344.)

POURTALESIA.

Pourtalesia A. AG., 1869, Bull. M. C. Z., I.
(See Part II. p. 344.)

Pourtalesia miranda

!**Pourtalesia miranda** A. AG., 1869, Bull. M. C. Z., I. p. 272.
(See Part II. p. 345.)

Pl. XVIII.

Straits of Florida; Shetland Channel.

* Should read AGASS., 1836, on p. 344, not AGASS., 1841.

HOMOLAMPAS.

Lissonotus (**A. Ag.**), 1869, Bull. M. C. Z., I. (non Schonh.)
Homolampas A. Ag., 1872, Rev. Ech., Pt. I., p. 137.
(See Part II. p. 347.)

Homolampas fragilis
! *Lissonotus* **fragilis** A. Ag., 1869, Bull. M. C. Z., I. p. 273.
! **Homolampas** *fragilis* A. Ag., 1872, Rev. Ech., Pt. I. p. 137.
(See Part II. p. 348.)

Pl. XVII. f. 13–21.

Straits of Florida.

PLATYBRISSUS.

Platybrissus Grube, 1865, Jahresb. d. Schles. Ges. f. Vat. Cult.

This genus forms the connecting link between the Spatangina, such as Spatangus proper, and genera closely allied to the Ananchytidae. The test is depressed (in the only species known); outline regularly elliptical; posterior extremity rounded; anal system placed in the uniformly swollen edge of the test. Ambulacra flush with the test, terminating abruptly at the extremity; poriferous zones nearly parallel; pores not conjugate. Actinostome large, with the edge forming an irregular polygon with a broad side at the posterior edge; anterior lip slightly sunken, so that the actinal opening is nearly on one level, much as we find it in Eupatagus, which genus Platybrissus strikingly recalls at first glance, though structurally so different. Actinal plastron small, not independent, reduced to a narrow point, extending a short distance in the broad bare actinal avenue, formed by the coalescence of the adjoining posterior ambulacral spaces. The total absence of fascioles of any kind, either peripetalous, anal, or subanal, is a remarkable feature possessed by many cretaceous Spatangoids; but it is the first case recorded of such a structure in any of the recent species. The tuberculation of the actinal surface is large, distant, with few small miliaries irregularly scattered; the largest tubercles are placed on the very edge of the bare actinal avenue, and near the actinostome; that of the abactinal surface is similar, but with secondary as well as miliary tubercles, decreasing in size towards the apex.

Platybrissus Roemeri

!**Platybrissus Roemeri** GRUBE, 1865. Jahresb. d. Schles. Ges. f. Vat. Cult., p. 61.

Pl. XXI^b. f. 3–4.

Test depressed; edge rounded; outline from above regularly elliptical; vertex posterior, immediately in front of the anal system; the test sloping very slightly from the anterior extremity to the vertex. Apical system anterior; four large genital openings. Odd anterior ambulacrum scarcely apparent, reduced to distant minute pairs of pores. Lateral ambulacral petals open at the extremity, elongate; poriferous zones narrow, of uniform width; pores close together; outer row largest, not conjugate. All the petals are flush with the test. The anterior zones of the anterior lateral ambulacra appear shorter than the posterior zones, owing to the small size of the three pairs of pores adjoining the apical system. The whole abactinal part of the test is covered by large secondary and miliary tubercles, distributed in the same manner over all the plates: from three to five larger tubercles, surrounded by distant miliaries, with about the same number of smaller secondary tubercles nearer the lower edge of the plates. The secondary tubercles become larger towards the ambitus; and on the actinal side, which is flat, we find only large, distant, primary tubercles, with few miliaries scattered between them. The actinostome is a segment of a circle, with the posterior lip so slightly lobed that it appears on the same level with the anterior lip. On the actinal side the anterior petals are only seen from the large buccal tentacles radiating from the mouth in the ambulacra, the posterior lateral ambulacra form a single broad avenue, occupying the whole central part of the posterior part of the test; they become separated near the posterior extremity by a small pointed shield of tubercles formed by the posterior interambulacral space; but this shield is not separated either as an actinal plastron or as a subanal plastron, neither of which exist in this genus. This triangular shield has a slightly pointed keel, somewhat anterior to the separation of the ambulacral fields on the posterior extremity. The posterior extremity is bevelled anteriorly from the top of the anal system towards the actinal keel. The anal system is pointed, elliptical; neither spines nor buccal or anal membranes were preserved in the specimens examined.

Locality not known.

SPATANGINA.

* Subfamily **Spatangina** GRAY, 1855, Cat. Rec. Ech.

Spatangoids with a flat test; petals lanceolate, not sunken, with broad interporiferous spaces flush with the test; the abactinal part of the poriferous zones usually rudimentary; a subanal plastron and large interambulacral tubercles within the peripetalous fasciole (Eupatagus), or in the interambulacral spaces.

The genera of this family, except Eupatagus, have no peripetalous fasciole. On this account Eupatagus has usually been associated with the Brissina, but from the structure of the petals I am more inclined to associate it with the Spatangina proper. In some genera we have an internal fasciolē forming a plastron which is placed above the margin. in the anterior part of the test, and partially obliterates the abactinal part of the anterior poriferous zone of the anterior lateral ambulacra.

SPATANGUS.

Spatangus KLEIN, 1734, Nat. Disp. Ech.

Test heart-shaped, with broad ambulacral petals; poriferous zones alone sunken; odd ambulacrum placed in a more or less deep, broad, anterior groove. Large tubercles on the five interambulacral spaces; subanal fasciole very prominent; no lateral or peripetalous fasciole.

Spatangus Lütkeni

! *Spatangus* **Lütkeni** A. AG., 1872, Bull. M. C. Z., III.

Test thick, distinguished at once by its regularly elliptical outline, indented anteriorly by the broad ambulacral groove; its test regularly arched, both transversely and longitudinally, truncated at the posterior extremity. The apical system is anterior; the vertex slightly posterior; the outline arching slightly but regularly from the anterior edge to the posterior edge, above the large, broad, elliptical anal system; the lower surface is much as in S. purpureus, somewhat convex; but the actinal plastron is elongate; the subanal plastron heart-shaped, about one and a half times as broad as long, while in S. purpureus it is three times as broad as long, and in S

* In the List of known species, p. 219, this subfamily is by mistake named **Euspatangina** A. AG.

Rashi scarcely more than one and a quarter times broader than long, and not exceeding in width the widest part of the actinal plastron. The actinostome is more distant from the anterior edge than in the two European species; the general proportions of the tuberculation and size of the spines much as in S. purpureus on the actinal side. The small tubercles covering the abactinal surface are much larger and more closely crowded than in the other species, covering the whole abactinal part of the test, including the anterior groove, with a very uniform granulation, carrying minute, slender, curved spines. In the apical portion of the anterior lateral interambulacra there are a few irregularly arranged primary tubercles carrying larger spines; on the outer slopes of the anterior groove, adjoining the ambulacral zones, irregular vertical lines of large primary tubercles, carrying large spines, are found extending from the apical system to the ambitus. The lateral petals are moderately broad, petaloid, proportionally shorter than in the other species. The color in alcohol is dark violet.

Long. Diam.	Trans. Diam.	Height.	Length Ant Lat Petals.	Width Porif. Zone.	Length Post. Petals.	Dist. Apical Syst. Ant. Edge.	Width Subanal Plastron.
81.	68.4	45.5	25.	5.	26.8	32.	18.

Japan.

Spatangus purpureus

!? **Spatagus purpureus** MÜLL., 1776, Prod. 2850.
Spatangus purpureus LESKE, 1778, KL. Add., p. 170.

Pl. XI^f. f. 19–22; Pl. XIV^a. f. 1; Pl. XIX^c. f. 5–6; Pl. XXVI. f. 24–27; Pl. XXXII. f. 17, 18; Pl. XXXIV. f. 3, 4; Pl. XXXVII. f. 16; Pl. XXXVIII. f. 34, 35.

The outline of the test of this species, seen from above, is pretty uniform; it is broadly heart-shaped, slightly angular, truncated at the posterior extremity. Anterior groove deepest near the ambitus; apical system slightly anterior; vertex posterior; geometrical pole about half-way between the two. The height is very variable. Posterior ambulacral petals petaloid, closed; interporiferous space broad; interporiferous zone more convex than the inner one. Anterior lateral petals longer than the posterior ones; odd anterior poriferous zone reduced to distant diverging rows of pairs of pores, the interporiferous space attaining its greatest breadth somewhat above the ambitus. Pores of lateral ambulacra large, connected by a deep furrow. The plates of the abactinal part of the interambulacral spaces carry large perforated crenulate tubercles of very variable size, most numerous adjoining the median line, and extending in a V-shaped line or forming a triangular

space towards the edges of the interambulacral plate. The large tubercles extend nearly to the anal system in the odd interambulacrum; in the lateral posterior interambulacra they reach the ambitus, or nearly so, in the anterior part of the space; in the anterior lateral ambulacra they extend to the ambitus. Adjoining the whole length of the anterior groove to the ambitus, there are prominent tubercles, closely packed, which gradually pass into the small, uniform-sized, secondary, perforated, indistinctly crenulated tubercles, which cover the whole of the abactinal part of the test, including the interporiferous zones; the miliaries are minute, forming irregular arcs running at a distance round the base of the small, well-separated secondaries. The miliaries are more numerous in the anterior groove, in the interporiferous space, than in the corresponding space in the petals. As the secondaries approach the ambitus they gradually increase in size, become more distinctly crenulated, and pass into the larger primary tubercles of the actinal side; the miliaries forming more or less regular circles round the bare scrobicular area; these increase regularly in size in the lateral ambulacra, till they reach the broad bare ambulacral avenues, extending from the mouth to the ambitus, — the anterior ones to the very edge of the subanal fasciole, and the others to the edge of the test. The ambulacral avenues are covered by minute distant miliaries. The actinostome is crescent-shaped, broad; posterior lip not remarkably prominent. The actinal plastron is elongate, triangular, with a slight keel near the central part. It is covered by large tubercles, gradually becoming smaller towards the median line. The posterior edge of the test, including a part of the actinal surface, is occupied by a large transverse subanal plastron, edged with a broad fasciole, with a deep re-entering angle below the transverse, elliptical, pointed anal system. The tuberculation of the subanal plastron is largest in the central part of the corresponding loops formed by the fasciole, on either side of the median line. The anal system is crowded by an outer row of nearly rectangular plates, succeeded by concentric and more irregularly shaped plates, gradually becoming smaller towards the anal opening; these plates carry a few miliaries.

The secondary tubercles carry short, slender, pointed, curved spines, longitudinally and transversely striated. The larger spines carried by the larger primary tubercles of the abactinal side and by the larger tubercles of the actinal side differ only in size from the smaller ones; they are lighter colored, usually of a yellowish tinge, while the smaller spines are of uniform and darker tint.

Seen in profile, the test rises rather more suddenly in the anterior part arching uniformly towards the truncated anal extremity. The actinal surface is nearly flat, sloping towards the edge; the actinal plastron alone sloping towards the ambulacra from the median line, forming an indistinct keel. The plates of the ambulacra on the actinal surface are elongate; the pores far apart, except immediately round the actinostome, to form the very marked phyllodes. The changes due to growth have been described by Lovén, and have been referred to in the description of the Florida Echini, Rev. Ech., Pt. II. p. 331.

Long. Diam	Trans. Diam.	Height.	Length Ant. Lat. Amb.	Length Post. Lat. Amb.	Width Post. Inter. Porif. Space.	Width Subanal Plastron.
105.	99.	48.	39.	38.	8.	41.
97.	87.	53.	36.	33.5	7.2	40.5
77.	71.	42.	28.	26.	5.8	28.5
67.	67.	32.	20.	20.5	4.	24.2
62.	58.	34.	20.	21.	3.1	22.5
40.	36.					

Norway; Mediterranean.

Spatangus Raschi

! *Spatangus* **Raschi** Lovén, 1869, Öfv. Skand. Vet. Akad. Förh.

Pl. XXV. f. 35; Pl. XXVI. f. 23.

This fine Spatangoid has been well figured by Lovén. It is easily distinguished from its European congener by the more angular outline of the test, seen from above, the great height of the test, the depth of the anterior furrow at the ambitus, and the narrow elongate pointed lateral petals. The primary tubercles of the abactinal part of the test have the same general arrangement as in S. purpureus; but they are smaller, more numerous in each patch, and extend to the edge of the test in all the interambulacral spaces. In the ambulacral plates, between the extremity of the petals and the edge of the test, smaller primary tubercles are crowded in the lower half of the ambulacral plates. Seen from the actinal side the test slopes from the edge towards the sunken actinostome, especially in the anterior part of the actinal surface of the test, where the slope is quite sharp. The actinal plastron is elongate, narrow, widest half-way to the posterior edge; the test sloping from the broad bare posterior ambulacral avenues to the indistinct keel, which extends from the very prominent posterior lip of the actinostome. The subanal plastron is heart-shaped, edged by a narrow fasciole,

scarcely wider than the actinal plastron. The anal system is transversely elliptical, proportionally much smaller than in S. purpureus, and is placed near the ambitus; the arch of the abactinal part of the posterior interambulacrum reaching nearer the ambitus than in S. purpureus, in which the truncated extremity of the posterior end is much larger.

The small tubercles covering the abactinal surface are smaller and more closely crowded than in S. purpureus, extending over the anterior groove; the miliaries are larger, consequently the spines which cover the abactinal surface are more uniform in appearance. The same is the case on the actinal surface; the tubercles increase greatly in size, but are not so large as in S. purpureus, either adjoining the bare ambulacra or in the actinal plastron. The color of the smaller spines of dried specimens is dark violet; the large spines are lighter-colored.

Long Diam	Trans. Diam	Height	Length Ant Lat. Petals.	Width Interp. Zone.	Length Post Lat. Petals.	Width Actinal Plastron.	Width Subanal Plastron.
66.	60.	34.9					
75.	67.	42.					
90.	79.	48.					
97.	87.	52.	37.5	3.	34.9	16.	20.

German Ocean; Azores.

(SPATANGUS.) Maretia.

Maretia Gray, 1855, Cat. Rec. Ech.

Test thin, flattened; large tubercles upon the interambulacral areas, except the odd one. Actinal plastron smooth, destitute of spines. No fascioles except a subanal one, which is more or less indistinct. Petals spreading, at same time elongate, extending nearly to the ambitus. Anterior groove indistinct, it disappears entirely on the abactinal surface.

This subgenus is distinguished from Spatangus proper by the great development of the bare posterior ambulacral spaces of the actinal side, the small, nearly smooth, actinal plastron, the thin flattened test, and different mode of arrangement of the primary tubercles. None of these characters are, however, features which seem to entitle Maretia to rank as anything more than a subgeneric division of Spatangus. Desor has distinguished as Hemipatagus, tertiary Spatangoids agreeing in every respect with the present generic division formerly established by Gray, from the single recent species known at that time.

Maretia alta

! *Maretia* **alta** A. AG., 1863, Proc. Ac. N. S. Phila., p. 360.

The outline from above is elliptical, rounded anteriorly, with a slight indentation at the ambitus formed by the shallow anterior groove. Posterior extremity truncated, nearly vertically, across the extremity of the petals. Seen in profile, the test is uniformly rounded from the anterior edge to the apical system, and rises gradually to the vertex, which is slightly anterior to the truncated posterior extremity. The test slopes regularly from the central line to the lateral edges of the test. Apical system anterior. Petals narrow, lanceolate, extending nearly to the edge of the test. Anterior poriferous zones of the anterior lateral ambulacra obliterated, with the exception of three or four outer pairs of pores. Anterior odd ambulacrum narrow, reduced to a few vertically distant pores, flanked near the apical system by a few larger primary tubercles; the rest of the abactinal surface, with the exception of a few large primary tubercles near the edge of the test in the posterior lateral interambulacra, is covered by minute, closely crowded secondary tubercles, carrying short, slender, curved spines. On the actinal surface the tubercles increase in size towards the bare ambulacral avenues, and are arranged diagonally, carrying proportionally longer and stouter spines. The actinal plastron extends half-way to the actinostome from the subanal plastron, forming a sharp beak at its posterior edge. The subanal plastron is heart-shaped, placed entirely within the truncated posterior extremity, surrounded by a broad fasciole, which extends to the lower edge of the large transversely elliptical anal system, placed at the upper edge of the truncated posterior plane.

The proportions of the anal system, of the subanal and actinal plastron, with the beak at its posterior edge, and the high test readily distinguish this species from M. planulata. "Of a light buff color above, radiated with rows of flesh-colored patches" (W. Stimpson). No large specimens of this species have yet been found.

Long. Diam.	Trans. Diam.	Height.	Width Subanal Plastron
20.3	16.	10.	7.

Japan.

Maretia planulata

Spatangus ovatus LESKE, 1778, KL. Add. (non LAMK. nec KL.).

!**Maretia** *planulata* GRAY, 1855, Cat. Rec. Ech., p. 48.

Pl. XIX^b. f. 7–12; Pl. XXV. f. 33–34; Pl. XXVI. f. 21, 22; Pl. XXXVII. f. 13, 14.

This is apparently one of the oldest species known, if I am correct in referring Leske's figure (Seba, III. *Pl. XV. f. 27, 28*) to this species, and it seems astonishing that a species apparently so common should not have been figured by Seba. The figure he gives is tolerably characteristic, and certainly appears to fit better M. planulata than Echinocard. flavescens to which it is universally referred. In profile the flat test slopes very gradually from the posterior edge to the vertex, which is somewhat above the anal system, and arches regularly towards the sides. Excellent figures of this species have been given by Michelin and by Martens. Test thin, depressed; outline from above slightly heart-shaped, rounded anteriorly, with a slight indentation at the ambitus, made by the shallow anterior groove; this disappears somewhat above the ambitus. The sides of the test are regularly rounded, slightly angular, broadest in the central or posterior part of the test; the posterior interambulacral space extends beyond the general outline, forming a more or less prominent, rounded keel, above the bevelled posterior anal extremity of the test; this slopes anteriorly. The large, pointed, longitudinally elliptical anal system occupies the whole of the posterior extremity of the test; the subanal plastron is broad, somewhat heart-shaped, surrounded by a narrow fasciole, frequently indistinct, or almost obliterated. This plastron is on the edge of the test, partly on the actinal surface, and partly on the bevelled portion of the posterior extremity.

The apical system is small; four genital openings close together, anterior to the centre. The poriferous zones of the broad petaloid lateral ambulacra slope up to the edge of the somewhat raised broad interporiferous spaces; the anterior ambulacra are the shortest. The odd anterior ambulacrum is flush with the test, except near the ambitus, where there is a slight groove; the pores are very minute, vertically distant, except near the apical system, where they are closely crowded. In the lateral poriferous zones the inner row is round, the outer elliptical, pointed; they are connected by an indistinct groove. The whole abactinal part of the test is covered by minute secondary, perforate and crenulate, tubercles, very variable in size, quite distant; the intervening space filled with miliaries, equally irregular in size. In the lateral interambulacral spaces there are large, sunken, primary

tubercles, perforate, crenulate, increasing in number towards the ambitus, arranged parallel to the upper horizontal sutures of the plates. The primary tubercles carry long, slender, curved spines, more than half the length of the test. The other tubercles carry similar curved spines, but quite short and slender. On the actinal side the posterior bare ambulacral avenues coalesce, forming a broad, bare actinal shield, slightly convex, terminating posteriorly in a small triangular actinal plastron, covered by secondary tubercles. The edge of the test is quite sharp, sloping towards the sunken actinostome, and the sides of the bare ambulacral spaces. The tubercles increase rapidly in size from the edge of the test inwards, and are arranged in diagonal rows in the lateral posterior interambulacra. The actinostome is large; the anterior lip is parallel to the posterior raised lip, on a lower level, forming a narrow parallelogram, bent in the middle, with rounded corners. The anterior phyllodes are well developed, extending to the edge of the test; the posterior phyllodes have but three or four pairs of parallel pores, extending a short distance beyond the actinostome. The development of the bourrelets in this species is quite marked. The bare actinal surface has a few distant miliaries, carrying minute, slender, curved spines; the spines of the large tubercles of the actinal surface are like the long spines of the abactinal side.

The coloration of this species is extremely variable, and has given rise to the distinction of several species. It is (in alcohol) frequently of a uniform straw color, with darker spots at the base of the primary tubercles on the abactinal side. In other specimens the abactinal part of the test is light, surrounded by a dark violet-brown margin, running completely round the edge of the test; the spines varying in color according to the position in the dark or light areas. In other specimens the ambulacral petals alone are colored violet-brown, with darker spots at the base of the primary spines. In others, again, we have a combination of the marginal coloring and of the dark ambulacral petals, forming irregular patches at the extremity of the petals; the coloring, when present, is usually strongest and most abundant in the lateral ambulacra; the odd ambulacrum is frequently only slightly colored, or of a uniform yellowish tint in mottled specimens. The primary spines are more or less intensely banded, according to the general tint of the specimen.

In large specimens the pores of the abactinal portions of the anterior zone of the lateral ambulacra are more or less indistinct; the pores of this anterior zone are usually smaller than those of the other zones.

Long. Diam.	Trans. Diam	Height	Length Ant. Lat. Petals	Length Post. Lat Petals.	Width Interp. Space Post. Pet.	Width Subanal Plastron.
65.	51.5	18.	23.	30.	6.	16.5
59.	49.	16.	21.	27.4	5.1	14.2
50.	41.8	13.	16.3	24.	3.9	12.4
38.	33.	13.	14.	18.9	3.	11.
30.	27.	11.5	9.	12.	2.1	9.5

Kingsmills; China; East India Islands; Mauritius.

(SPATANGUS.) EUPATAGUS.

Eupatagus AGASS., 1847, Ann. Sc. Nat., VIII.

Test thin, depressed, elliptical. Ambulacral petals arched, not sunken, closed; interambulacral areas covered by large tubercles, as in Spatangus proper, crenulate and perforate, but not extending beyond the elliptical peripetalous fasciole. No anterior groove; subanal fasciole present, no large tubercles in the odd interambulacral space.

The identity of Eupatagus and Plagionotus (Metalia), suggested by Haime, does not seem to extend to more than a close affinity; Eupatagus forming, as it were, a connecting link between the true Spatangoids, which have a pitted anal plastron, and the Brissidae, where the anal plastron is simple. This genus has the peripetalous fasciole of Plagionotus (Metalia), while it has the ambulacra of Spatangoids proper.

Eupatagus Valenciennesii

! **Eupatagus Valenciennesii** AGASS., 1847, C. R. Ann. Sc. Nat., VIII. p. 9.

Pl. XV^a. f. 3–4.

Test thin, depressed; outline from above elliptical; elongated posteriorly; posterior interambulacrum truncated. Posterior pair of petals once and a half as long as the anterior pair, with a nearly elliptical interporiferous space, pointed towards the apical system, rounded at the extremity, and closed. Anterior pair lanceolate, pointed at the extremity; anterior poriferous zone narrow; posterior zone twice as broad as the anterior one. Poriferous zone of the posterior ambulacra slightly broader than the posterior zone of the anterior ambulacra. Poriferous zones of petals consisting of an inner row of rounded pores, conjugated by an indistinct furrow, with the outer large triangular pore; poriferous zones of lateral petals slightly sunken; odd anterior ambulacrum reduced to minute pairs of pores placed close together,

flush with the test. Genital openings four in number, close together; posterior pair slightly diverging at the anterior extremity of the madreporic body, which extends into the posterior interambulacral space; ocular spots forming a large pentagon, enclosing in the central part the genital openings. Peripetalous fasciole broad, elliptical, running round the extremity of the lateral petals and across the odd ambulacrum, slightly above the ambitus. The tuberculation of the abactinal surface is uniform below the peripetalous fasciole; the tubercles are distant, becoming more closely crowded towards the ambitus and near the anterior extremity. There are from three to five large isolated tubercles in the posterior interambulacral spaces above the fasciole, from two to three similar large tubercles in the anterior interambulacra next to the petals, and on each side of the odd ambulacrum a number of somewhat smaller tubercles, arranged in irregular transverse rows. The edge of the test is rounded; the actinal surface is flat, with the exception of the slight keel formed by the posterior extremity of the interambulacral actinal plastron; the mouth is slightly sunken at the anterior extremity. The actinal anterior and posterior lateral ambulacra form short bare avenues, while between the lateral posterior interambulacra and the posterior end of the plastron the posterior ambulacra form broad, bare, smooth bands, extending to the subanal fasciole and to the anal system. The subanal fasciole is closed, heart-shaped, broad, with an indistinct anal branch. Seen in profile, the test arches regularly to the vertex, which is anterior to the apical system, then runs in a nearly horizontal line to the slight crest extending above the anal system. The anal system is large, pyriform, situated in the vertically truncated posterior extremity, of which it occupies nearly the whole space. From the edge, towards the actinostome, the tuberculation becomes gradually more distant and coarser; it is of uniform size, smaller and closer than in the rest of the actinal side in the actinal plastron, except on the keel. In the subanal plastron it forms diverging rows, becoming smaller towards the fasciole, radiating from a small, nearly bare space.

In dried specimens the spines are of a grayish color with silvery lustre, curved, stout; the spines of the larger tubercles and of the actinal side do not differ from those of the abactinal side, otherwise than in being longer and more curved at the base. The spines of the subanal plastron form a well-marked, pointed tuft. The actinostome is large, nearly circular, with a small labiate posterior edge; the buccal membrane is strengthened by a pavement of small, irregularly circular, limestone plates.

Australia.

LOVENIA.

Lovenia Des., 1847, C. R. Ann. Sc. Nat., VIII.*

The ambulacral petals are somewhat triangular, adjoining zones form two crescents on each side of the apex, with the concave sides towards each other. Large tubercles upon the upper part of the test, except in the posterior interambulacrum. There is an internal fasciole as in Echinocardium and in Breynia, but no peripetalous fascioles as in the latter; a well developed anal fasciole extends into the pit in which the anal system is placed. Test thin, elongate, arched, flattened, truncated posteriorly; remarkably large ampullæ support the large tubercles, and form a close pavement on the inner surface, over the whole floor of the actinal portions of the test, they correspond to the large tubercles of the upper part of the test; these commonly carry long curved spines; anterior groove slight; pores very small.

Lovenia cordiformis

! *Lovenia* **cordiformis** Lütk., 1872, in A. Ag., Bull. M. C. Z., III.

Differs from the other species of the genus by the greater convexity of the anterior part of the test, its more anterior apical system, the small number of primary tubercles in the lateral ambulacral spaces, and the small size of the internal pouches of the primary sunken tubercles of the actinal surface. The great flatness of the posterior edge of the actinostome is remarkable, as well as the comparatively large size of the tubercles on each side of the flat abactinal part of the odd anterior ambulacrum, within the internal fasciole (not within the peripetalous fasciole, as was accidentally printed in the original description). The posterior extremity of the test is vertically truncated; the anal system is not deeply sunken as in L. elongata; the whole of the subanal plastron is within the posterior edge of the test; the broad upper part of the fasciole alone spreading into the slightly re-entering lower edge of the posterior extremity of the test, immediately below the anal system. The actinal plastron is small, triangular, at the posterior edge of the actinal surface.

* On p. 139, 3d line, for **Lovenia** Agass, 1847, C. R. . . . . . read **Lovenia** Des., 1847, in Agass., C. R. . . . . .

This species is more closely allied to the Japanese Lovenia than to L. elongata; it has a few characters recalling the latter.

Guyaquil; Gulf of California.

Lovenia elongata

! *Spatangus* **elongatus** GRAY, 1845, EYRE Voyag., I.
! *Lovenia elongata* GRAY, 1851, Ann. Mag. N. H.

[*17, 18; Pl. XXXVIII. f. 27, 28. Pl. XIX^c. f. 1–4; Pl. XXV. f. 31; Pl. XXVI. f. 35, 36; Pl. XXXVII. f.*

Test depressed, flat, pointedly heart-shaped from above; edge of the test angular; anterior groove deep at the ambitus; posterior interambulacral space extended, truncated, bevelled inwardly. Greatest breadth between the apical system and the anterior edge; genital openings close together; madreporic body small. Internal fasciole of uniform breadth, surrounding an elongate, posteriorly pointed plastron, crossing the ambulacra at right angles, slightly concave towards the apical system; the odd ambulacral zones run along the edge of the flat abactinal plastron, the anterior half of which is covered on both sides of the odd ambulacrum by rows of secondary tubercles, with sunken scrobicular circles on the posterior edge only, five to six in each row, diverging from the anterior ambulacrum, which is flat, with a narrow interporiferous space, covered by minute granulation (miliaries) in the centre, while between the pores on the edge there are minute secondary tubercles with flat scrobicular circles, similar to those covering the remainder of the internal plastron, but smaller. The anterior ambulacral petals are triangular; the anterior poriferous zones obliterated; the posterior zones forming, with the anterior zones of the posterior lateral ambulacra, a nearly confluent arc, separated by a short space, formed by the narrow abactinal part of the interambulacral space.

The posterior petals are more elongate; the posterior zones meet at the posterior edge of the internal plastron, which extends a short distance beyond the apical system. The poriferous zones of the lateral ambulacra are slightly sunken; the pores vertically distant; the zones are continued to the edge of the test, flush with the test, as pairs of small pores placed close together. The anterior groove commences at the anterior edge of the abactinal plastron; the flat plastron extending below the fasciole along the sides of the groove to form a flat keel. The abactinal part of the test, outside the fasciole, is covered by minute, closely-packed, raised, secondary tubercles

of a uniform size, with few distant miliaries. In the anterior interambulacra, and the anterior half of the lateral posterior interambulacra, there are large primary tubercles, perforate, not crenulate, with deeply sunken scrobicular circles of various sizes, carrying powerful, long, curved spines, often equalling two thirds of the test in length.

On the actinal side the tubercles of the interambulacral spaces increase in size rapidly towards the bare ambulacra; the scrobicular circles are deeply sunken; and the tip of the tubercle is bridged by a narrow space, curving outward, connecting it with the anterior part of the test.

The actinostome is crescent shaped, with rounded ends, twice as broad as long. The phyllodes are short; pores distant, but prominent. The actinal surface is nearly flat; the posterior lip of the actinostome forming a slight keel. The bare spaces of the ambulacra are connected, so that the greater part of the actinal surface is free from tubercles. The actinal plastron is semicircular, limited to the posterior extremity of the actinal surface. The posterior extremity slopes anteriorly from the upper edge; the anal system is situated at the bottom, on the upper side, of the deep inverted funnel, which divides the subanal plastron into two almost disconnected portions. The fasciole is convex posteriorly, behind the actinal plastron, forming two lateral loops, which spread over the edge, so as to cover the whole of the inverted funnel of the posterior extremity below the anal system. The anal system is longitudinally elliptical, pointed towards the lower edge; the membrane is covered by an outer row of large plates, with smaller concentric rows of plates towards the anal opening. On the lateral shields of the subanal plastron there are from eight to ten large primary tubercles, carrying long, stout curved spines, forming two tufts on each side of the sunken posterior extremity. The primary tubercles of the actinal side carry long, slender spines, less curved than those of the abactinal side. The actinal plastron is covered by minute secondaries, somewhat larger towards the anterior edge, carrying short, stout, curved spines, while the spines of the abactinal surface are short, slender, silk-like. The ambulacra on the actinal side are covered by slender, short spines, mounted on miliaries, scattered irregularly. The color in alcohol is a brilliant light violet; the large spines are lighter colored, banded with darker shades of violet. On the actinal side the coloring is lighter and of uniform tint. In small specimens the coloration is uniform, and the large spines are not prominently banded. A fine series of species collected by McAndrew in the Red Sea shows

considerable changes due to growth, the young being long, high, while larger and older specimens become gradually broad, flat, and angular.

Long. Diam.	Trans. Diam.	Height.	Length Internal Plastron.	Width Subanal Plastron.	Distance Actinost. from Ant. Edge.
83.	65.	27.	36.	32.5	35.
64.	52.	22.5	25.8	28.	29.
55.	47.				
37.5	30.	12.8	14.5	15.	16.
27.	21.	11.	9.	10.5	11.1

Red Sea; Australia; Philippine Islands.

Lovenia subcarinata

! *Spatangus* **subcarinatus** GRAY, 1845, EYRE Voyage, I.
! *Lovenia subcarinata* GRAY, 1851, Ann. Mag. N. H.

Only small specimens of this species are known; the test is high, elongate, narrow. The anterior edge of the test is strongly keeled on each side of the odd anterior ambulacrum. The posterior extremity of the test slopes gradually outward from the vertex to the upper edge of the subanal plastron. The anal system is but slightly sunken, and the upper edge of the fasciole surrounding the abactinal plastron is not lost in the depression of the anal system. The shape of the actinostome is quite different from that of L. elongata; it is small, nearly triangular, with rounded edges; while it is narrow, transverse, in elongata. This feature, and the re-entering posterior extremity of L. elongata, in which the test slopes inward from the upper edge of the anal system to the actinal surface, are sufficient to distinguish at once the two species; for, in small specimens of L. elongata, no larger than those of L. subcarinata, the posterior extremity, although more vertically truncated, yet shows by the general position of the anal system, and the shape of the actinostome and subanal plastron, the essential structure of the larger specimens.

China; Japan; Sandwich Islands.

BREYNIA.

Breynia Des., 1847, Ag., C. R. Ann. Sc. Nat., VIII.

Large Spatangoids with a thick test; remarkable for the presence of three kinds of fascioles not usually found associated in other Spatangoids, viz. an internal, subanal, and peripetalous fasciole. Large tubercles, deeply sunken, are enclosed in a space formed by the peripetalous fasciole. The internal fasciole causes an atrophy of the abactinal part of the petals, as in Echinocardium. Gray suggested, in 1851, the propriety of making this genus a subdivision of Echinocardium. The presence of a marked peripetalous fasciole, and the peculiar character of the large tubercles, would seem sufficient (if any grounds are valid) among Spatangoids, to maintain at present both these generic types.

Breynia Australasiae

Spatangus **Australasiae** Leach, 1815, Zool. Misc., II. p. 68.

? *Breynia Australasiae* Gray, 1855, Cat. Rec. Ech.

Pl. XV^a. f. 7–9; Pl. XXV. f. 32; Pl. XXVI. f. 20.

Test thick; outline from above elliptical, slightly broader in the anterior part, indented by a shallow, odd anterior ambulacral groove, truncated posteriorly towards the actinostome. Apical system anterior, with four genital openings, placed close together; vertex posterior, in front of the anal system, half-way between the inner angle of the ambulacra and the truncated posterior edge. Seen in profile the abactinal part of the test is nearly horizontal, arching very gradually towards the anterior edge, where the test drops suddenly. Actinal surface flat, with the exception of the slightly sunken sides of the large polygonal actinostome, and the short keel at the posterior edge of the small triangular actinal plastron. Peripetalous fasciole following the outline of the test, except in the anterior interambulacrum, before it crosses the odd ambulacrum, where it makes a short rectangular step. The peripetalous fasciole is formed of a series of lozenge-shaped elongate links. The internal fasciole is pointed posteriorly, it extends from the geometric centre, with nearly parallel sides to its sudden crossing of the odd ambulacrum, at one third the distance from the apical system to the edge of the test. The apical portion of the anterior poriferous zones of the anterior lateral ambulacra is completely obliterated by the internal fasciole. The pores of the odd am-

bulacrum are minute, vertically distant; the interporiferous space is bare, flanked by a row of larger miliaries, and a number of irregular smaller miliaries. The anterior lateral petals are triangular; the posterior zones slightly curved towards the anterior extremity, they extend nearer the apical system, and are separated only by a narrow space from the anterior zones of the posterior lateral ambulacra; these are more petaloid, the posterior zones coming to a point on each side of the median posterior interambulacral line. In the lateral interambulacra, within the peripetalous fasciole, there are from eight to ten large tubercles, perforate, not crenulate, with a sunken scrobicular area, carrying, as in Lovenia, huge spines curved towards the posterior edge, equalling half the test in length. On each side of the odd ambulacrum small secondary tubercles are crowded in irregular patches; similar patches are found along the median line of the posterior interambulacrum. The whole of the abactinal surface is covered by small raised tubercles of uniform size, carrying slender, silk-like curved spines; they increase gradually in size near the ambitus, where they are more crowded; and on the actinal side they become larger and quite distant in the whole of the anterior part of the test, leaving only the short, bare ambulacral avenues on the sides of the actinal plastron, covered by a few minute miliaries. Round the actinostome the tubercles are small, closely packed, imitating bourrelets between the phyllodes. The spines of the actinal surface correspond in size to the increase of the size of the tubercles. The subanal plastron is heart-shaped; the fasciole surrounding it broad; the upper line of the fasciole is not sharply defined, forming a broad band below the anal system, and sending off indistinct anal branches. The posterior part of the test immediately below the anal system is somewhat re-entering; the anal system is elliptical, longitudinal, pointed. In the specimens with spines which I have seen in the British Museum Collection, the color of the test is a dark chocolate; the spines are of a light violet. The buccal and actinal membranes were not preserved in the specimens examined.

Long. Diam.	Trans. Diam.	Height.	Dist. Apical Syst. Ant. Edge.	Dist. Actinost. Ant. Edge.	Width Actinal Plastron.	Width Subanal Plastron.
73.	59.	35.	28.	19.5	15.	28.
63.5	53.	31.3	25.	17.	14.4	26.5

China; Australia; Japan.

ECHINOCARDIUM.

Echinocardium GRAY, 1825, Ann. Phil. (pars.)
(See Part II. p. 349.)

Echinocardium australe

! *Echinocardium* **australe** GRAY, 1851, Ann. Mag. N. H., p. 131. [*Pl. XXXVII. f. 15.*

Specimens of this species are readily distinguished from the Atlantic E. cordatum, to which it is closely allied. Seen in profile the test rises somewhat more gradually from the anterior extremity towards the apical system; the abactinal pole is more central, and the anal system is elliptical, slightly transverse, instead of being longitudinal, as in E. cordatum. The bare abactinal posterior ambulacral areas extend to the ambitus, remaining of the same width, instead of becoming narrow, as in E. cordatum; the pores of the poriferous zones are more distant than in E. cordatum.

Japan; New Zealand; East India; Cape of Good Hope.

Echinocardium cordatum

Echinus **cordatus** PENN. 1777, Brit. Zool., IV. p. 58.
Echinocardium cordatum GRAY, 1848, Brit. Rad.
(See Part II. p. 349.)

Pl. XIX f. 10–17; Pl. XX. f. 5–7; Pl. XXV. f. 27, 28; Pl. XXXIII. f. 6.

Norway; Mediterranean; Brazil; Florida.

Echinocardium flavescens

Spatagus flavescens MÜLL., 1776, Prod., p. 235.
! *Echinocardium flavescens* A. AG., 1872, Rev. Ech., Pt. I. p. 110.
(See Part II. p. 351.)

Pl. XX. f. 3–4; Pl. XXV. f. 26, 26′.

Norway; South Carolina; Florida.

Echinocardium mediterraneum

! *Amphidetus* **mediterraneus** FORBES, 1844, Journ. Lin. Soc. Lond.
! *Echinocardium mediterraneum* GRAY, 1855, Cat. Rec. Ech.

Pl. XXV. f. 29; Pl. XXVI. f. 19.

Test high, flattened above, with deep sloping sides, as broad as long. The anterior extremity is vertically truncated, with a shallow vertical groove; the

abactinal pole is anterior; the internal fasciole surrounds a broad, flat, triangular, internal plastron, extending to the edge of the vertically truncated anterior extremity. The abactinal part of the test is nearly horizontal from the anterior edge of the fasciole, and the confluence of the posterior zones of the posterior lateral ambulacra. The posterior interambulacrum rises as a rounded keel above the general level of the upper part of the test. The posterior extremity is bevelled; the anal system vertically elongate. The subanal plastron extends in a sharp beak beyond the general outline of the test. The bare posterior actinal ambulacral avenues are broad; actinal surface flat.

The lateral anterior ambulacra descend nearly perpendicularly along the sides of the test; this, and the short posterior interambulacral keel, distinguish E. mediterraneum from E. pennatifidum.

Mediterranean.

Echinocardium pennatifidum

? *Amphidotus gibbosus* (**Barrett**), 1857, Ann. Mag. N. H. (non AGASS.)
? *Echinocardium* **pennatifidum** NORM., 1868, 4th Dredg. Rep. Shetland.
(See Part II. p. 351.)

Pl. XX. f. 1-2; Pl. XXXII. f. 16.

Northumberland; Straits of Florida.

LESKIADAE.

Subfamily **Leskiadae** GRAY, 1855, Cat. Rec. Ech.

No distinct subanal or actinal plastron; a peripetalous fasciole, enclosing slightly sunken petaloid ambulacra. Anal system covered by a small number of plates; actinostome pentagonal, covered by five converging plates, flush with the actinal surface.

PALEOSTOMA.

Leskia (**Gray**), 1851, Ann. Mag. (non ROB. DES., 1830).
Paleostoma LOVÉN, 1867, Vetensk. Ak. Forhdl.

Test ovoid; actinostome flush with surrounding parts of the test; actinal membrane covered by five triangular valves; actinal and subanal plastrons indistinct; peripetalous fasciole slightly sinuous. Anus covered by five to eight converging valves, forming a pyramid over the anal system; two large, prominent ovarian openings. Gray and Lovén have established a distinct family for this interesting genus; it is as yet known only from a few specimens, and those described are evidently the young, as Simpson in his notes says, "the dead tests of this species (P. mirabilis) show that it grows to a length of three inches." The mere presence of a pentagonal actinostome, flush with the test, does not seem sufficient grounds for a separation from the Brissina, any more than the presence of a few anal plates covering the anal system; we find a pentagonal mouth, flush with the test surrounding it, in many young Spatangoids, and in all young Spatangoids we have also few anal plates. Until we know more of this interesting genus it seems unnecessary to make any changes in their systematic position, or suggest any other views than those adopted by Lovén and Gray, as this genus may prove to belong to a distinct family among Spatangoids, corresponding to the Arbaciadae among the regular Echini, when we know something more of the adult than the mere fact that in large specimens the anal pyramid is not composed of a materially greater number of plates than in the young. Lütken has already pointed out that the presence of a limited number of anal plates was by no means an unusual structural feature among Echini. In the first part of this Revision I have added two genera to the regular Echini formerly known, with only four or five anal plates. The presence of a limited number of buccal plates, how-

ever, can only be homologized to the regular large buccal tentacular plates which are found in all young Echini, and which, in many genera, always retain a greater preponderance, and in the young cover nearly the whole of the actinal membrane. Though in young Spatangoids we find a smaller number of actinal plates, yet nothing thus far has been observed in which a regular radial arrangement exists; all the Spatangoids with pentagonal actinostome having a membrane covered with a large number of small plates of nearly uniform size.

Paleostoma mirabilis

! *Leskia* **mirabilis** GRAY, 1851, Ann. Mag. N. H.
! **Paleostoma** *mirabilis* LOVÉN, 1867, Vet Ak. Forhdl., p. 432.

Pl. XXXII. f. 13–15.

The specimens of this species in the British Museum are smaller than the figures given by Gray, in his Catalogue of Recent Echini, and show marked differences from the young specimens collected by Kinberg, in the Stockholm Academy Museum, from which the Cambridge Museum owes a couple of specimens to the kindness of Lovén.

In the specimens described by Gray, which are by no means adult (as shown by fragments collected by Simpson), the test is ovoid, with a rather angular outline; the vertex is nearly central, slightly anterior. The lateral ambulacra are broad, petaloid, rounded at the extremity, somewhat sunken. The posterior pair much the shortest; the odd anterior ambulacrum placed in a rather broad, very slightly sunken, groove, with rudimentary poriferous zones of vertically distant pores; peripetalous fasciole broad, somewhat angular, following in its general curve the outline of the test. There are two very large, transversely elliptical, ovarian openings; actinal surface convex; actinal plastron oval, but not differently tuberculated from the rest of the test, hence does not appear in striking contrast to the rest of the actinal surface, as in other Spatangoids.

Anal system circular, placed near the upper extremity of the rounded posterior extremity, covered by six to seven large triangular converging plates; the anal opening itself surrounded by a number of minute pointed plates. The actinostome is anterior, pentagonal, flush with the surface of the surrounding test; the angles of the pentagon corresponding with the ambulacra. The sides of the pentagon form the base of short triangular

plates (the vertex turned towards the actinal centre), with concave sides, to which are attached the movable triangular valves, converging at the actinal opening; the concave sides of the bare plates forming a petal round the actinostome, into the central line of each of which the slit of the converging triangular plates runs, forming thus a set of ten movable plates, soldered to a set of basal plates, forming the pentagonal outline of the actinostome.

The young specimens described by Lovén would at first glance be taken for young of Brissopsis; they have the same cylindrical test, rounded at the extremity; a slightly sinuous peripetalous fasciole; short lateral ambulacra with but few pores in the poriferous zone, with immense ambulacral suckers projecting through the pores of the odd ambulacrum; the anal system covered by comparatively few plates, and a pentagonal actinostome. The anal system in Brissopsis soon becomes covered by a larger number of plates, the actinostome assumes a crescent-shaped form, and a prominent posterior lip is developed; while the presence of a well developed subanal and anal fasciole shows, in the earliest stages, even important typical structural differences. It is interesting to note that Platybrissus, which has also an actinostome flush with the test, has neither anal nor subanal fascioles, nor a peripetalous fasciole, while Homolampas has only anal and subanal fascioles. The spines of the young are curved, slender, slightly spathiform, longest at the anterior extremity. Lovén has noted the presence of tridactyle toothed pedicellariæ.

China; East India Islands.

BRISSINA.

Subfamily **Brissina** Gray, 1855.

The plastrons formed by the fascioles are more numerous in this family than in the other subfamilies of Spatangidae. We sometimes find well developed anal, subanal, as well as peripetalous and lateral fascioles occurring together. The petals are usually equally developed, and the abactinal system elongate, more or less sunken, with narrow median interambulacral spaces, generally narrower than the poriferous zones, and covered only by miliaries.

HEMIASTER.

Hemiaster Des., 1847, Ag. C. R. Ann. Sc. Nat., VII.

Troschel was the first to call attention to the identity of structure of some of the species of Tripylus, as established by Philippi, with Hemiaster, and to suggest the propriety of uniting two of its species with Hemiaster. He was prevented, however, from carrying out his suggestion by laying too much stress upon the variation of structure of the anal lateral fasciole,—structural features which we now know, from the study of the young of several Spatangoids, to furnish no valuable generic characters. The peripetalous and subanal fascioles are the only ones which are subject to changes of shape and not of quantity during their growth, and from their construction we may form generic divisions, taken in connection with other structural features. This has led me to consider many of the genera recognized as simply subgeneric sections of Hemiaster — which are well and sharply marked from our present stand-point, but which are based upon altogether too limited materials — to be nothing more than temporary subdivisions. The subgenus may be characterized by the presence of a peripetalous fasciole, with more or less sunken petals, or shallow anterior groove; the presence of an abactinal subanal fasciole forms the subgenus Brissopsis; a subanal fasciole with anal branches, and a well-developed actinal plastron, characterizes the subgenus Rhynobrissus. With a lateral fasciole, as in Agassizia and Schizaster, and deeply sunken lateral ambulacra, the subgenus Tripylus, as limited here, is formed. The ambulacral structure of Faorina, combined with a simple peripetalous fasciole, and the addition of a well-

defined anal fasciole, together with the subanal fasciole, as in Brissopsis, forms the subgenus Rhynobrissus; the typical Hemiaster includes only small, short Echini, with a depressed test, truncated posteriorly, without a well-defined actinal plastron, and more or less sunken ambulacra, while the high conical species resembling Micraster, with bare vertical median interambulacral and ambulacral sutures, with an indistinct anal fasciole and an imperfect actinal plastron, form the subgenus Faorina. It seems almost useless to attempt a better definition of these subgenera with the limited material at our command, and when additional specimens are discovered we may find better reasons than we now have for adopting or discarding the subdivisions of the genus Hemiaster, and the association of the species as here proposed.

Hemiaster australis

! **Tripylus australis** PHIL., 1845, Wieg. Archiv., p. 347.
! *Hemiaster australis* A. AG., 1872, Rev. Ech., Pt. I. p. 132.

Pl. XXV. f. 3.

The outline of the test of this species varies considerably seen from above. In some specimens it is exactly like the outline of H. cavernosus, — angular, pointed posteriorly; while in other specimens in which the test is, perhaps, slightly more depressed, the outline is more regularly elliptical, nearly as broad as long. These specimens Professor Lovén is inclined to consider as distinct species, though the material at our command seems hardly sufficient for a determination of the question. There is also a slight difference in the proportion of the anterior and posterior ambulacral petals, and the peripetalous fasciole is usually broader than in the angular specimens; but in both these features we find considerable difference in the specimens I have been able to examine, which leads me to suppose that additional material would show a range of variation great enough to include, as characteristic of one species, all the differences mentioned above.

The apical system is more central than in H. cavernosus; the depth of the anterior ambulacral groove is the same, but the lateral ambulacra are only slightly sunken. The pores of the poriferous zones vertically distant the poriferous zones as broad as the median space; ambulacra slightly petaloid, straight; the posterior petals sometimes very slightly arched outward at the extremity. The pores of the odd anterior ambulacrum are especially distinct as far as the peripetalous fasciole. This, with the exception of the

small re-entering angle in the posterior lateral interambulacra, follows generally the outline of the test; it varies greatly in breadth in some specimens; the width of the fasciole is nearly as great as the width of the petals, in others it does not equal the width of the poriferous zones. The genital pores are small. There is no marked difference in the tuberculation of this species from that of H. cavernosus, except that the tubercles adjoining the petals are somewhat larger, compared to those of the intermediate spaces. The shape of the actinostome and its position is essentially the same as in H. cavernosus. The spines resemble those of H. cavernosus on the actinal side; the large tubercles carry long, straight, slightly curved, and club-shaped spines, with a short groove at the extremity; the other spines are similar in structure, but shorter.

Patagonia.

Hemiaster cavernosus

! **Tripylus cavernosus** PHIL., 1845, Wieg. Archiv., p. 347.
! *Hemiaster cavernosus* A. AG., 1872, Rev. Ech., Pt. I. p. 132.

Pl. XXI^c. f. 1, 2.

This species would at first glance, on account of its deeply sunken lateral ambulacra, be taken as the young of Tripylus excavatus; specimens of the same size of the latter species show the presence of the lateral fasciole as fully and clearly marked as in older specimens; while the absence of this fasciole, and the different shape of the actinostome and of the posterior part of the test, are sufficient to distinguish these species, belonging, as they do, to different subgenera. The test is depressed; outline from above pentagonal, with rounded angles; posterior extremity vertically truncated. Apical system and vertex coincident; the apical system scarcely sunken below the level of the surrounding interambulacral ridges. Anterior and posterior lateral ambulacral petals sunken, nearly of the same length; anterior somewhat the longest. Anterior groove very shallow, — a mere indentation of the anterior part of the test. Peripetalous fasciole following in its general outline the outline of the test, with a concave side in the lateral posterior interambulacra. Test in profile arching regularly towards the ambitus; actinal surface slightly convex, with an indistinct rounded keel near the posterior extremity of the actinal plastron. Actinostome small, broad, crescent-shaped near the the anterior edge; posterior lip but little prominent; anal system comparatively large, longitudinally elliptical, pointed at the two poles. On the

actinal side the tuberculation of the anterior part of the test is coarse, distant, decreasing rapidly in size towards the ambitus, and remaining tolerably uniform over the actinal surface, diminishing in size somewhat towards the apical system; larger tubercles are found on the edges of the sunken ambulacra, and on each side of the anterior groove. The spines are short, club-shaped, slightly curved, grooved at the tip, and somewhat flattened; they vary in length according to the size of the tubercles, but, apparently, not materially in shape.

Philippi, in his description of this species, mentions finding in each one of the posterior ambulacra a small sea-urchin, which he takes to be the young of it. It is totally unlike the adult, and seems to be a stage previous to the development of the petals. When the mode of development of this species is better known it may throw some light upon the apparently abnormal mode of development, discovered more recently by Grube, in a species of (Echinobrissus) Anochanus. Color of dried specimens is yellowish-brown test, with greenish-gray spines.

I could find no trace of the subanal fasciole in the specimens I have examined, such as has been figured by Philippi; he does not mention it in the text of his description.

Long. Diam.	Trans. Diam.	Height.	Length Post. Pair Amb. Pet.	Length Ant. Pair Amb. Pet.	Dist. Apical Syst. Ant. Edge.	Dist. Mouth Ant. Edge.
33.	30.5	19.	12.9	13.3	15.	5.9
35.	32.		13.3	13.5	15.5	

Patagonia; Chili.

(HEMIASTER.) Tripylus.

Tripylus Phil., 1845, Wieg. Archiv.

Test depressed, heart-shaped; apical system anterior. Lateral ambulacra sunken; anterior groove slight. Actinal side flat. Peripetalous fasciole, with continuous lateral and anal fascioles. This subgenus represents the Schizaster type of Hemiaster.

Tripylus excavatus

! **Tripylus excavatus** Phil., 1845, Wieg. Archiv., p. 344.

Pl. XXI^c. f. 4.

Test thin, depressed; outline from above heart-shaped, slightly truncated posteriorly; apical system slightly anterior to centre; vertex posterior, half-

way along the rounded keel, extending between the apical system and the truncated anal extremity, which is nearly level, only slightly arched. Anterior extremity sloping gradually at first, then arching towards the ambitus. Anterior groove narrow, extending to the actinostome. Lateral ambulacra broad, deeply sunken, the anterior rectangular, extending nearly to the ambitus, rounded at extremity; the posterior shorter than the anterior, with posterior edge more arched than anterior edge. Apical system flat, with three huge elliptical genital openings. The peripetalous fasciole is rounded anteriorly, where it descends near to the ambitus, re-entering slightly near the extremity of the anterior lateral petals, forming a deep re-entering angle in the lateral posterior interambulacral areas, and only a slight indentation across the odd posterior interambulacrum; the posterior part of the fasciole is narrow from the point of branching of the lateral fasciole (the extremity of the anterior petals); this arches towards the apical system in the median interambulacral space, curving gradually downward, and passing below the anal system near the ambitus, forming a nearly straight line across the posterior edge. The anal system is situated at the upper end of the posterior extremity; it is longitudinally elliptical, small, strengthened by an outer row of larger plates, gradually becoming smaller towards the anal opening. The actinal side is flat. The posterior ambulacra form distinct, bare avenues, extending nearly to the ambitus in both sides of the broadly triangular actinal plastron. The actinostome is narrow, transverse, with a prominent posterior lip, nearly one quarter the width of the test in length. The tubercles of the actinal side are large near the ambulacra, diminishing rapidly towards the ambitus; the whole abactinal part of the test is covered by a close, minute granulation, carrying short, club-shaped spines, slightly curved, grooved at the top, and flattened. On the actinal edge of the sunken ambulacra are found larger tubercles, which carry similar, only larger, spines, extending from both sides across the ambulacra, and hiding them in part. The spines of dry specimens were of a light-green color; the denuded test grayish-pink.

Long. Diam.	Trans. Diam.	Height.	Width Ant. Pair Amb. Pet.	Length Ant Pair Amb. Pet.	Depth Ant. Pair Amb. Pet.	Length Post. Pair. Pet.	Width Post. Pair Amb. Pet.
46.	48.	27.	7.	20.5	9.	16.	6.5

Patagonia.

(HEMIASTER.) RHYNOBRISSUS.

Rhynobrissus A. AG., 1872, Bull. M. C. Z., III.

Test thin; outline from above diamond-shaped; vertex posterior; lateral ambulacra petaloid. Odd anterior ambulacrum flush with the test. Peripetalous fasciole existing with independent anal and subanal fascioles. Anal fasciole forming a closed anal area. Tubercles remarkable for the great development of the flat, raised, scrobicular area. Spines of abactinal surface short, silk-like, curved; on the actinal surface long, curved. Posterior lateral ambulacra passing gradually into the actinal surface, without forming a marked edge of the test in the posterior extremity. The edge of the test is well defined in the anterior actinal extremity.

Rhynobrissus pyramidalis

! **Rhynobrissus pyramidalis** A. AG., 1872, Bull. M. C. Z., III.

Pl. XXIII[a]. f. 4-6.

Test thin; outline from above diamond-shaped; the greatest breadth is across the apical system, which is slightly anterior to the centre. The vertex is posterior, somewhat in front of the bevelled sharp posterior extremity, just within the posterior edge of the peripetalous fasciole. Seen in profile the outline slopes regularly from the edge, slightly arched to the vertex, curving sharply from the vertex, as far as the anal system. The anal system is placed in a shallow depression of the sharp bevelled posterior extremity; this is truncated vertically from the subanal plastron, and joins in a beak the extremity of the elongate actinal plastron, narrowest at its posterior extremity, where it meets the diamond-shaped subanal plastron, bound by a broad fasciole. The central line of the actinal plastron forms an angular keel, which becomes more prominent towards the posterior extremity of the plastron. The anterior part of the actinal surface is flat, forming a sharp angle with the abactinal surface at the ambitus; in the posterior lateral interambulacra the actinal surface slopes towards the broadest part of the test; the ambitus rising to form a sort of node, and then arching regularly from this point towards the sharp bevelled posterior edge of the test; the actinal surface is thus reduced, in the posterior part of the test, to the width of the plastron, the posterior end of which is gradually rounded, and, without forming a distinct ambitus, passes to the vertical face of the posterior half of the lateral interambulacral spaces.

The lateral ambulacral petals are short, extending about two thirds towards the edge from the apex; they are limited by the peripetalous fasciole, which follows in a general way the outline of the test, except the slight indentation in the posterior lateral ambulacra. The lateral ambulacra are somewhat sunken, petaloid, remarkable for the great width of the poriferous zones, which leave only a narrow interporiferous space, a mere thread, carrying a few distant miliaries, not a quarter of the width of the adjoining poriferous zone; the petals are straight, rounded anteriorly; the pores large, elliptical, nearly of the same size; the inner pores the larger, the posterior petals the longest; anterior petals diverging slightly anteriorly; the anterior poriferous zone more arched than the posterior one. The odd anterior ambulacrum is flush with the test, narrow, consisting of hexagonal or pentagonal plates, with minute pores in the median angles of the junction of the plates. The tubercles (imperforate, not crenulate) of the whole of the upper part of the test above the ambitus are uniform, closely packed, with distinct raised scrobicular circles, and few most minute miliaries irregularly scattered. Near the apical system, in the upper part of the odd ambulacrum, we find a cluster of rather larger tubercles, carrying spines considerably larger than those of any other part of the abactinal surface; a narrow line along the horizontal and vertical sutures is left bare. Within the peripetalous fasciole the tubercles increase in size immediately adjoining the poriferous zones; and the spines are large enough to cover the whole width of the petals. The spines are slender, short, curved, of uniform size over the whole abactinal surface, except within the fasciole, as mentioned above, and towards the lower side of the posterior extremity outside of the anal fasciole, where the tubercles increase in size, and carry larger and longer spines, but similarly curved to the shorter ones. The tubercles gradually increase in size, and reach their maximum adjoining the bare actinal ambulacral avenues. In the anterior part of the test the tubercles increase rapidly in size to the edge of the bare areas round the actinostome. In the actinal plastron they are largest on the edge near the anterior extremity, diminishing in size towards the keel and the posterior extremity. The spines of the actinal surface are very long; those of the actinal plastron are arranged in diagonal rows, curving towards the central part of the plastron; those of the lateral posterior ambulacra are slightly S-shaped, curving outward at the extremity. The ambulacral avenues are covered by slender curved miliary spines, carried by miliary tubercles somewhat irregularly and closely scattered over

them. The actinostome is very large transversely, nearly equalling one third the width of the test; it is crescent-shaped; the posterior lip not prominent; the bare ambulacral avenues are connected round the actinostome, forming a broad, bare, anterior space, extending into a point towards the edge in the lateral ambulacra, and in the posterior lateral ambulacra, and as a gradually narrowing avenue on both sides of the actinal plastron; the extremity of the bare posterior ambulacra widens again at its junction with the subanal fasciole, at the narrowing of the posterior part of the actinal plastron. The anterior side of the actinal membrane is covered by large, irregular, hexagonal plates, occupying the greater part of the membrane; the rest is covered by irregularly arranged, smaller, imbricating scales. The lateral anterior phyllodes are prominent; the pores close in the odd anterior one; the phyllodes run parallel to the edge of the actinostome; they are short in the odd ambulacrum; in the posterior ambulacra the pores are distant. The broad anal fasciole extends some distance above the anal system; it commences immediately above the subanal plastron, but it is not connected with it. The anal system is placed near the summit of the posterior extremity; a secondary subanal plastron is formed by a broad transverse band, extending below the anal system, forming, by the extension to a point of the inner part of the upper and lower part of the fasciole, two nearly disconnected, small, diamond-shaped areas. The formation of sub-areas by the fascioles is thus far known only in Faorina, in which the anterior part of the peripetalous fasciole forms one, and sometimes two, independent areas.

The anal system is elliptical (longitudinally); the anal membrane covered by numerous small plates, decreasing towards the anal opening, which projects, slightly trumpet fashion, beyond the level of the posterior edge.

The color of the spines in dried specmens is a delicate light-gray, with a rose tint.

In a small specimen not measuring more than $17^{mm.}$ in length, and not having more than eleven pairs of pores in the posterior lateral ambulacra, we find no material change which is not readily explained by difference in size; the specimen fully described above measures $61^{mm.}$. The flat scrobicular circle is not so prominently developed, and the general outline from above is less angular; in profile the anterior extremity is quite abruptly truncated, and does not slope regularly from the edge as in the adult. The test is extremely thin; the ambulacral petals comparatively more sunken; the fascioles broader, as is the case in all young Spatangoids;

the anal and subanal fascioles were developed, but had not the outline they assume in the adult. The general color of the tests and spines was straw-colored.

Long. Diam.	Trans Diam.	Height.	Dist. Ap. Syst. Ant. Edge.	Length Ant Pair Amb Pet.	Length Post. Amb Pet.	Width Porif. Zone.	Width Interp. Space.	Width Actino-stome.	Width Subanal Plastron.
61.	52.1	36.3	19.8	17.	19.	18.	5.	17.	14.

China.

(HEMIASTER.) Brissopsis.

Brissopsis Agass., 1840, Cat. Syst. Etyp., p. 16.
(See Part II. p. 354.)

Brissopsis luzonica

! **Kleinia luzonica** Gray, 1851, Ann. Mag. N. H., VII. p. 133.
! *Brissopsis luzonica* A. Ag., 1872, Rev. Ech., Pt. I. p. 95.

The mere confluence of the lateral ambulacra does not constitute, as I have shown in the history of the changes of Brissopsis lyrifera, a sufficient reason for separating generically the East India species from Brissopsis, as has been done by Gray. It is true that this confluence commences earlier than in the European species; but it is found in the latter; and the other structural features agree so well with Brissopsis, that it is impossible not to associate these species in the same genus.

Test thin; seen from above the outline is rounded anteriorly, indented by the odd ambulacral groove, pointed towards the posterior extremity, which is bevelled. The general outline in profile does not differ materially from that of Brissopsis lyrifera, the test perhaps sloping somewhat more towards the anterior edge. The lateral ambulacra are confluent; the anterior arched towards the posterior end at the extremity; the posterior, arching towards the peripetalous fasciole, run parallel to the curve of the ambulacra in the posterior interambulacra, and as the apical portions of the posterior poriferous zone of the posterior lateral ambulacra are wholly obliterated, the posterior extremity of the peripetalous plastron is pointed, compared with its outline in Brissopsis lyrifera. The subanal plastron is divided by a vertical branch in two parts (this is rudimentary, or does not exist in B. lyrifera); the anal branch of the fasciole is prominent; the anal system is smaller in proportion to the size of the test than in B. lyrifera. The anterior groove is somewhat deeper. The general mode of arrangement

of the tubercles on the plates is the same as in B. lyrifera; we have in this species a cluster of large tubercles, carrying long spines between the peripetalous fasciole and the outer edge of the lateral petals and the sides of the odd ambulacrum, which gives the apical part of the test a very different aspect from that of B. lyrifera; the continuation of the sunken ambulacral groove beyond the peripetalous fasciole to the ambitus, and beyond on the actinal side, is quite well defined, forming a slight indentation at the edge of the test, especially deep in the anterior lateral ambulacra, which form a well-defined, broad, bare, and shallow groove as far as the ambitus, and extending from the peripetalous fasciole to the actinostome.

The color of the spines was silver-gray in dried specimens.

Luzon; Siam; New Caledonia.

Brissopsis lyrifera

! *Brissus* **lyrifer** FORBES, 1841, Brit. Starf., p. 187.
! *Brissopsis lyrifera* AGASS. DES., 1847, C. R. Ann. Sc. Nat., VIII. p. 15.
(See Part II. p. 354.)

Pl. XIX. f. 1–9; Pl. XXI. f. 1–2; Pl. XXXVIII. f. 36–38.

Norway; Mediterranean; Florida.

AGASSIZIA.

Agassizia VAL., 1846, Voyage Vénus.
(See Part II. p. 353.)

Agassizia excentrica

! *Agassizia* **excentrica** A. AG., 1869, Bull. M. C. Z., I. p. 276.
(See Part II. 353.)

Pl. XI^f. f. 23, 24; Pl. XIV. f. 9–12.

Florida Gulf Stream.

Agassizia scrobiculata

! **Agassizia scrobiculata** VAL., 1846, Voyage Vénus Atlas, *Pl. I. f. 2.*

Pl. XIX^a. f. 1–3; Pl. XIX^b. f. 1–3.

Owing to the inaccurate drawings of this species given by Valenciennes, it has been described again under different names by Gray and Lütken; a

comparison of the original specimens leaves no doubt of the identity of the three so-called species described from the Pacific side of Central America.

Test thin, ovoid; apical system nearly central, slightly posterior, coincident with the vertex; outline from above elliptical, rounded anteriorly, slightly truncated posteriorly; greatest breadth of the test across the central part. Anterior ambulacral furrow narrow, shallow, but little sunken near the apical system, and flush with the test at the ambitus. Anterior lateral ambulacra somewhat more sunken, extending to the ambitus. Posterior lateral ambulacra short, petaloid, with wide poriferous zones, and narrow interporiferous space, somewhat over half the width of the poriferous zone. Apical system small; genital openings close together. Peripetalous fasciole with a deep re-entering angle in the posterior lateral ambulacra, from which it extends parallel to the anterior petals, as far as the ambitus, makes a right angle, and crosses in a slightly curved line the anterior part of the test; this part of the fasciole is the broadest. The lateral fasciole arises above the extremity of the anterior petals, extends nearly on the same level, slightly concave upwards towards the anal system, forms a sudden angle, running to a point from both sides below the anal system, so far on the actinal surface as to form an indentation in the posterior part of the actinal plastron. The anal system is transversely elliptical, large; no anal plates are preserved in any of the Museum specimens. The actinal surface is slightly convex; near the posterior extremity of the broad actinal plastron there is a short rounded keel. The posterior bare ambulacral avenues are narrow, and do not extend to the ambitus. The actinostome is anterior, transverse, narrow, with a prominent posterior lip. The fact that the anterior row of pores, forming the continuation of the anterior poriferous zones of the anterior lateral ambulacra, stops suddenly near the actinostome, seems to show that in Agassizia it is the whole of the anterior poriferous zone of the anterior lateral petals which is obliterated. This structure exists already in the youngest specimens I have examined. The tuberculation is quite irregular; the tubercles of the actinal surface in the anterior part of the plastron are large, closely packed, arranged in transverse oblique rows, forming a regular pavement, diminishing gradually in size towards the posterior end. In the lateral posterior interambulacra the tubercles are large, distant, decreasing slightly in size towards the fasciole; in the actinal part of the anterior part of the test the tubercles are large, distant, diminishing gradually in size across the fasciole as far as the apical system; the tubercles adjoining the lateral anterior

ambulacra are larger than those adjoining the odd anterior ambulacral groove. The whole of the posterior part of the test above the ambitus is covered by closely packed, smaller tubercles; the anterior furrow carries along the median line only minute miliaries; near the apex the test is covered by a tuberculation similar to that of the adjoining parts of the test near the ambitus. The odd anterior poriferous zones are reduced to double pores, vertically distant.

The color (in alcohol) of specimens covered with spines was yellowish-gray; the spines are slender, curved.

Panama; Gulf of California.

BRISSUS.

Brissus Klein, 1734, Nat. Disp. Ech.
(See Part II. p. 356.)

Brissus carinatus

! *Spatangus* **carinatus** Lamk., 1816, An. s. Vert., p. 30.
! *Brissus carinatus* Gray, 1825, Ann. Phil., p. 9.

Pl. XXI^a. f. 1–3; Pl. XXV. f. 36, 37; Pl. XXVI. f. 38.

This species, which has a very wide geographical distribution, varies also considerably, and its different stages of growth have been described as distinct species. The principal difference between this species and B. unicolor consists in the outwardly curved course of the posterior half of the posterior lateral ambulacra, which are shorter than the anterior, if much curved; the more angular peripetalous fasciole, forming one deep re-entering angle in the posterior interambulacrum, across the high rounded keel, which extends from the apical system to the posterior extremity. In the anterior lateral ambulacra the fasciole forms two deep re-entering angles, crossing the narrow odd ambulacrum at an obtuse angle. The posterior extremity is more obliquely truncated than in B. unicolor, where it is nearly vertical. In young specimens the test is more depressed (B. depressus); the keel not so prominent; the posterior extremity rounded, and the difference in the direction of the lateral petals not marked, as it gradually becomes in older and larger specimens. The test of dried specimens is frequently mottled; the central part of the plates is dark, leaving the edge light or white. The width of the peripetalous fasciole is greater in young and smaller specimens than in the

adult, where it is usually narrow and sharply defined. The spines of this species are perhaps slightly stouter than in the other species; they vary in dried specimens in color from a dark brown to a uniform silver-gray. The outline of the test from above varies from greatly elongate, pointed posteriorly, with the greatest breadth across the apical system, to a nearly pentagonal outline with rounded anterior edges, and the greatest breadth across the extremity of the posterior lateral ambulacra. This species reaches a large size: specimens measuring 140$^{mm.}$ in length are in the Museum collection. The subanal plastron is less in width than the broadest part of the actinal plastron; the actinal surface increases in convexity with age.

Long. Diam.	Trans. Diam.	Height.
140.	110.	80.
123.	98.	74.
110.	97.	61.5
92.	73.	47.8
69.	49.	40.
53.	40.5	28.

Society Islands; Sandwich Islands; East India; Mauritius; Philippine Islands.

Brissus obesus

! *Brissus* **obesus** VERRILL, 1867, Notes on Radiata, p. 316.

This species has been described by Professor Verrill, and distinguished from B. unicolor by the more evenly rounded outline between the anterior margin and ovarian plates, the more swollen posterior region, the increased convexity of the subanal and ventral areas, the less anterior position of the abactinal area, and the relatively shorter and broader subanal plastron. The difference in size of the genital openings and of the abactinal system in specimens of the same size, the slightly narrower lateral ambulacral petals and larger anal system in B. obesus, seem the most constant characters. It may perhaps turn out that this species is only a variety of Brissus compressus, which I have united with B. carinatus. As I have already stated, when describing B. unicolor, I find great difficulty in distinguishing the species of Brissus, and I have been led to unite as one species the Brissidae described from the Mediterranean and West India Islands. With ampler material at our command the question of the identity or difference of the species found on the two sides of the Isthmus of Panama might be decided. This is desirable, as it is one of the few species of Echini where the discrimination of the Atlantic and Pacific representatives is somewhat doubtful.

Panama; Gulf of California.

Brissus unicolor

!**Brissus unicolor** KLEIN, 1734, Nat. Disp. Ech.

(See Part II. p. 357.)

Pl. XXII. f. 1, 2; Pl. XXXVII. f. 19.

West India; Cape Verde Islands; Mediterranean.

(BRISSUS.) METALIA.

Plagionotus (**Agass.**), 1847 (non MULS. 1842).
Metalia GRAY, 1855, Cat. Rec. Ech. (emend.)
(See Part II. p. 360.)

Metalia africana

! *Plagionotus* **africanus** VERRILL, 1871, Notes on Radiata, p. 569.
! *Metalia africana* A. AG., 1872, Rev. Ech., Pt. I. p. 144.

It is with considerable doubt that this species is maintained as distinct from the West Indian M. pectoralis. The few specimens of the latter existing in our collections show a very wide range of variation, and, as several of the West Indian species are also found on the West Coast of Africa, this may prove to be only a variety of our West Indian species; although the principal differences noticed in the two specimens examined by Mr. Verrill may prove sufficiently constant, with additional material, to maintain their specific identity. These differences consist in the smaller number of plates covering the anal system (in M. africana), the presence of large tubercles on the anterior or lateral interambulacra, above the peripetalous fasciole, the comparatively narrower peripetalous fasciole, and especially the outline of the actinostome, which is broad, transversely, in the African specimens, and much more rounded anteriorly and long in the West Indian specimens.

Metalia maculosa

Echinus **maculosus** GMEL., 1788, LINN. Syst. Nat.
! *Metalia maculosa* A. AGASS., 1872, Rev. Ech., Pt. I. p. 144.

Pl. XXI^b. f. 8–9; Pl. XXVI. f. 39; Pl. XXXVIII. f. 29.

Test depressed; outine from above elliptical, slightly indented at the anterior edge, truncated posteriorly. Greatest breadth across the extremity of the posterior petals. Vertex posterior; apical system more central than in M. sternalis; ambulacral petals small, narrow, slightly sunken; peripetalous fasciole, with one small re-entering angle, near the posterior

extremity of the anterior lateral ambulacra, and a somewhat more decided re-entering angle in the anterior lateral interambulacral space. Genital pores larger and more distant than in specimens of M. sternalis of the same size. The petals are narrow, complete to the abactinal pole, with broad poriferous zones; the posterior petals longer than the anterior ones. Within the peripetalous fasciole the plates carry large primary tubercles, arranged in vertically distant, irregular, transverse rows in all the interambulacral spaces. The whole anterior part of the test is covered by similar primary tubercles, which diminish in size as they extend towards the posterior lateral interambulacra, below the fasciole, where the tubercles are small, crowded, similar to those which cover the whole abactinal part of the test to the ambitus. The actinal side is convex; the actinal plastron narrow, elongate, terminating in a prominent beak at the posterior extremity. The subanal plastron is diamond-shaped, edged with a broad fasciole; the bare ambulacral avenues are broad; the tubercles of the lateral interambulacra and anterior part of the test are large, diminishing very gradually towards the edge from the ambulacra. Those of the actinal plastron are large near the actinostome, small towards the posterior extremity.

The actinostome is large, somewhat broader than long. The anal system is pear-shaped; the anal opening nearer the lower edge; the anal plates numerous, polygonal, arranged concentrically, largest near the upper edge of the system. Anal branch of fasciole does not reach the abactinal surface. This species receives its name from the fact that the tubercles of the abactinal surface do not entirely cover the coronal plates, but leave the edges more or less bare; the median posterior interambulacral suture is especially prominent in dark-colored specimens; the contrast between the bare and tuberculated areas is very prominent. The color, denuded, is light violet; sutures lighter colored, or of a light yellowish-brown tint. The spines are short, curved, slender, light yellowish-pink. Those of the actinal side longer and stouter, and on the actinal plastron flattened at the extremity.

This species is closely allied to M. sternalis; the principal differences are its depressed test, its more central apical system, its narrow ambulacral petals, and its well-separated posterior petals. The odd anterior ambulacrum is flush with the test, except towards the ambitus, as it approaches the fasciole, and below it, where it is placed in a slight indentation of the test; while in M. sternalis we have a deep angular anterior groove, already commencing near the summit.

Long Diam.	Trans. Diam.	Height.	Dist Apic Syst Ant Edge.	Dist. Actin Ant. Edge.	Length Post Amb Pet.	Width Post. Petals.	Width Subanal Plastron.
78.	63.	34.	25.	17.	26.	5.	20.
58.	47.	29.	22.5	12.	23.	4.2	15.3
45.5	39.	23.5	17.	9.	17.5	4.	14.
43.	36.	21.9	15.9	10.5	15.	3.1	12.

Samoa: Sandwich Islands: Australia: Mauritius: Panama.

Metalia pectoralis

Echinus **grandis** Gmel., 1788, Linn. Syst. Nat.
! *Metalia pectoralis* A. Ag., 1872, Rev. Ech., Pt. I. p. 144.
(See Part II. p. 361.)

Pl. XXI. f. 4, 5.

West India Islands: Florida.

Metalia sternalis

! *Spatangus* **sternalis** Lamk., 1816, An. s. Vert., p. 31.
! **Metalia** *sternalis* Gray, 1855, Cat. Rec. Ech., p. 51.

Pl. XXI^a. f. 4, 5; Pl. XXI^c. f. 5–9; Pl. XXXII. f. 11, 12; Pl. XXXVII. f. 20.

This species grows to a large size, and the differences due to age are quite remarkable. In the largest specimens I have seen, measuring 150$^{mm.}$ in length, the outline of the test from above is elliptical, slightly angular, truncated posteriorly; the anterior edge deeply indented at the ambitus by the ambulacral groove. Seen in profile, the test rises vertically at the anterior extremity almost to the summit. The apical system is anterior, within the depressed abactinal part of the interambulacra, which rise above the general level of the termination of the petals; the posterior part of the test is concave; from the apical system towards the posterior edge the abactinal surface of the test is flattened. In specimens slightly younger the posterior part of the test, seen in profile, is straight; it is even convex near the edge of the posterior part of the interambulacrum. The genital pores are large, circular, close together. The odd ambulacral groove is shallow, flat at the abactinal pole, becoming deeper towards the edge, but narrowing again below the peripetalous fasciole. The lateral anterior ambulacra are sunken, broad, elongate, somewhat rounded at the outer extremity; the poriferous zones broad; the pores large, connected by a deep groove. The abactinal part of the anterior ambulacra is pointed; the poriferous zones forming a slight angle with the trend of the rest of the petal. The lateral posterior ambulacral petals, for a considerable distance from the apical system, are narrow, elon-

gate, slightly diverging, running parallel to the narrow interambulacral space which separates them. At about one third their length, the inner poriferous zone, which remains thus far rudimentary, reduced to a mere line of distant pores, increases rapidly in width, the whole course of the petal is deflected outwardly, and at about half the length of the petal the two poriferous zones are of equal width, and, remaining so, run almost parallel to the extremity, where the poriferous zones become somewhat narrower at the rounded end of the petal. The outer portion of the petal curves slightly inward. The actinal surface of the large specimens is convex, flattened in the median interambulacral space, and rounded towards the edges, especially in the lateral posterior interambulacral spaces. The flat actinal plastron is narrow, elongate, rounded at the two extremities, with a slight keel, forming two low nodes at the posterior edge of the two principal plates composing it. It is edged by the narrow, bare, posterior lateral ambulacra, which extend till they meet the subanal plastron, then diverge, following the line of the plastron, and are lost in the tubercles before reaching the edge of the test.

The subanal plastron is broad, heart-shaped, occupying nearly the whole of the posterior part of the sloping actinal surface of the test. It is edged by a very broad fasciole, broadest at the posterior edge, sending off a narrow anal branch, which remains open, but extends to the abactinal surface above the anal system. The anal system, situated in the upper part of the depression of the posterior part of the test, is elliptical longitudinally, pointed above and below; the posterior part of the subanal fasciole is on the edge of the depression of the test in which the anal system is placed.

The peripetalous fasciole forms across the posterior interambulacrum and the posterior lateral interambulacral spaces an open rectangle, with rounded corners and slightly undulating sides. The width of the fasciole equals in breadth the median interporiferous space of the posterior petals. It forms a right angle parallel to the anterior petals, at a short distance from it, and then runs diagonally towards the extremity, which it crosses at right angles to the trend of the petal, then diverges at the same angle on the other side of the petal, forming a deep re-entering angle in the anterior lateral interambulacra. It then runs obliquely towards the ambulacral furrow, and at a distance from it runs at a less angle towards the median line of the odd ambulacrum. The actinostome is transverse; the phyllodes well developed.

With the exception of the short diagonal rows of somewhat large tubercles along the edges of the petals and of the odd ambulacrum, within the peri-

petalous fasciole, the whole abactinal part of the test is covered by small, distinct tubercles, perforate and crenulate, with large, flat, indistinct scrobicular circles, and but few miliaries scattered between. On the actinal side the tubercles increase rapidly in size towards the ambulacra, where they attain their greatest size, and are quite distant; the tubercles of the actinal plastron diminish rapidly from the edge to the median keel.

The tubercles of the posterior part of the subanal plastron increase in size from the outer edge; they run in curved radiating lines towards the middle transverse line, from which the rows of tubercles radiate towards the anterior edge, becoming smaller, and forming more numerous rows as they approach the fasciole, between the deeply sunken pores, which are placed adjoining the fasciole, and from which slight grooves extend between the radiating rows of tubercles. These large specimens show, perhaps, better than in any other Spatangoid I have had occasion to examine, that the pores of the subanal plastron are formed by the posterior poriferous zones of the posterior lateral ambulacra.

In smaller specimens, which have been described as Xanthob. Garetti, the test is more globular, swollen; the outline of the posterior interambulacrum regularly arched; the posterior extremity vertically truncated. The posterior petals arched outwards; only a small part of the abactinal part of the posterior zone rudimentary. The peripetalous fasciole but slightly sinuous, and re-entering little in the lateral interambulacra. The actinal side quite convex, and the subanal plastron placed entirely on the vertically truncated posterior extremity. It is comparatively more diamond-shaped, nearly as high as broad; the broadest part of the fasciole is on the sides in this stage of growth. The spines are short, slender, cylindrical, slightly curved, of uniform size on the abactinal surface, except adjoining the edge of the petals within the peripetalous fasciole, and on the sides of the odd anterior ambulacrum. On the lower side they are longer, but otherwise not different. They are, in dried specimens, of a brilliant straw-color; in alcohol the color is more grayish.

Very small specimens do not differ essentially from the above; the posterior ambulacral petals are straight, well separated to the apex by the intervening interambulacral space; the posterior petals are relatively shorter, and the peripetalous fasciole scarcely forms a re-entering curve within the lateral interambulacra. The subanal plastron is as high as broad, diamond-shaped. An excellent series of specimens of all sizes, collected in New

Caledonia, in the possession of M. Crosse, and a smaller lot of specimens of different sizes in the Stuttgard Museum, have satisfied me of the identity of the species here united; I can consider them only as differences due to growth.

Sandwich Islands; Society Islands; East India Islands; Australia; Red Sea.

(BRISSUS.) MEOMA.

Meoma GRAY, 1851, Ann. Mag. N. H.
(See Part II. p. 358.)

Meoma grandis

! **Meoma grandis** GRAY, 1851, Ann. Mag. N. H., VII. p. 132.

Pl. XXVI. f. 28–38; Pl. XXXIV f. 1, 2.

Test more flattened or arched than in the somewhat conical M. ventricosa; readily distinguished by its coarser and more distant tuberculation, both within and without the peripetalous fasciole on the abactinal side, the deeper anterior groove at the ambitus, its less angular peripetalous fasciole, especially in the posterior interambulacrum. The ridge separating the pairs of pores carries but few large miliaries at the outer edge of the poriferous zone; while in M. ventricosa this line is formed of closely packed small miliary tubercles, extending to the median interporiferous space. The principal differences to be noticed on the actinal side are the shorter actinal plastron, and the anteriorly curved subanal fasciole, which crosses the actinal plastron in a straight line in M. ventricosa. The great size and distant tuberculation of the actinal surface, as well as the comparatively broad ambulacral avenues, readily distinguish the Pacific from the West Indian species. The spines are quite short, stout, very slightly curved. The color, when alive, is a dark chocolate-brown. This species lives buried in the sand at a depth of from two to three fathoms.

Acapulco; Gulf of California.

Meoma ventricosa

! *Spatangus* **ventricosus** LAMK. 1816, An. s. Vert., p. 29.
! *Meoma ventricosa* LÜTK., 1864, Bid., p. 120.
(See Part II. p. 358.)

Pl. XX. f. 8; Pl. XXII. f. 3, 4; Pl. XXVI. f. 31–34; Pl. XXXVIII. f. 24, 25.

Florida; West India Islands.

LINTHIA.

Desoria (**Gray**), 1851, Ann. Mag. N. H. (non AGASS., 1841).
Linthia MER. 1853, in DES. Act. Soc. Helv.

This genus unites structural features common to several genera. It has, like Brissus, a shallow anterior groove, though quite broad, and lateral anterior petals at right angles to the odd ambulacrum; narrow, long, and sunken lateral ambulacra. Peripetalous fasciole angular, re-entering in the lateral interambulacra. Lateral fasciole extending under the anal system. The general course of the fascioles and the principal features of the actinal side are those of Agassizia. The general outline of the test and the structure of the lateral ambulacra and the course of the peripetalous fasciole is that of Brissus.

I have associated Desoria with Linthia. It was first distinguished by Gray as Desoria, but, as this name was preoccupied, I have retained its synonyme, Linthia; it is, however, impossible in the present state of our knowledge of allied recent Spatangoids to give any satisfactory reasons for associating the only recent species with Linthia rather than with Periaster, nor do I feel convinced that the generic characters assigned to Prenaster and Pericosmus are sufficient to distinguish them accurately from fossil species alone; for they can be referred, to judge from the data obtained by the study of recent species, to either of the genera mentioned above. The greater or less distance of the peripetalous fasciole from the petals is not of great importance, to judge from its variation in the young, as its proximity or distance appears to depend greatly upon age.

The genera Periaster, Prenaster, Linthia (Desoria), Agassizia, and Schizaster all agree in having a peripetalous fasciole and a lateral fasciole branching from this, forming the subanal fasciole; the fact that in Linthia the peripetalous fasciole follows the course of the ambulacral petals is not sufficient to separate it as a genus from Periaster, as was already suggested by Desor, in his Synopsis. I would therefore propose to maintain the genus Linthia, with Periaster as a subgenus, in which the peripetalous and lateral fasciole are continuous, the peripetalous fasciole not surrounding the petals.

Linthia australis

! *Desoria* **australis** Gray, 1851, Ann. Mag. N. H., VII. p. 132.
! *Linthia australis* A. Ag., 1872, Rev. Ech., Pt. I. p. 138.

Pl. XIX^a. f. 7–9; Pl. XXI^b. f. 5–7.

Test thin; outline from above elliptical, angular. Anterior groove descending to the ambitus; posterior extremity vertically truncated. Apical system anterior, about one third the length from the anterior edge; vertex central. The central part of the lateral interambulacral plates form a series of irregular ridges, extending from the apical system to the ambitus. These ridges are less marked in small specimens. The posterior interambulacrum rises to the vertex from the apical system, extending as a more or less angular keel, most distinct at the apical part, towards the anal system; odd anterior ambulacrum broad, diverging to the ambitus; pores closely crowded near the apex, becoming quite distant at the ambitus, extending to the actinostome; intervening space covered by large distant miliaries. The lateral ambulacra are sunken; the anterior at right angles to the odd ambulacrum, elongate, curved anteriorly at the extremity, reaching almost to the ambitus. The posterior petals somewhat shorter, diverging near the extremity; poriferous zones of lateral ambulacra broad, as broad as the median bare interporiferous spaces; pores of zones large, round, joined by indistinct grooves, well separated vertically; apical system small; madreporic body elongate; four genital openings, equidistant, or posterior sometimes diverging. Peripetalous fasciole narrow, angular, with a re-entering angle in each median interambulacral space; the deepest angle in the lateral posterior interambulacra. It crosses the anterior groove near the ambitus, forming an acute angle across the ambulacrum. The lateral fasciole starts above the extremity of the anterior lateral petal, sloping towards the ambitus; near the posterior edge it forms a sudden curve, and passes under the anal system at the ambitus, a considerable distance below it. The actinal surface is slightly concave; the actinostome near the anterior edge small, broad, with distinct phyllodes, and bare posterior ambulacral avenues. The actinal plastron is broad, triangular, slightly re-entering at the posterior extremity.

The anal system is high, pointed, narrow, covered with an outer row of large rectangular plates, the largest at the lower part of the system, and with smaller inner concentric rows, gradually decreasing in size towards the central anal opening.

The tuberculation of the abactinal surface is small, uniform, with the

exception of the vertical rows of large primary tubercles, with bare scrobicular areas on each side of the anterior ambulacral groove, above the peripetalous fasciole. The tubercles increase in size towards the rounded ambitus, especially at the anterior extremity; from the ambitus they increase rapidly towards the ambulacra and actinostome, where they are largest and quite distant, owing to the greater size of the bare scrobicular areas. The miliaries are small, closely packed in the intervening spaces between the tubercles, both above and below. The tubercles of the actinal plastron are largest towards the actinostome, decreasing in size near the posterior extremity; a few large rounded tubercles adjoining the pores near the actinostome give the phyllodes an unusual degree of prominence.

In young specimens the outline is more ovoid; the test is less angular and gibbous than in the older specimens. The posterior ambulacral (actinal) avenues diverge towards the edge, while, as the specimens become older, they converge somewhat, forming a re-entering curve before they trend towards the edge. The posterior petals also simply diverge from the apical system, and, with increasing age, become somewhat curved outward at the extremity; though at no time do we find the least trace of confluence or suppression of the pores in the abactinal extremity of the posterior zones of the posterior lateral ambulacra; the petals are invariably well separated by the intervening interambulacral space, which forms a rounded keel.

One of the British Museum specimens is covered with short spines like those of Brissus; the coloring of the specimen figured by Gray seems anomalous, as all the other specimens are of a uniform tint, without the mottled coloring of the central part of the plates. A similar pattern of coloration sometimes occurs in M. sternalis, B. carinatus, and B. unicolor.

Long. Diam.	Trans. Diam.	Height.	Ant. Lat. Amb. Pet.	Dist. Apical Syst. Ant. Edge
61.	50.	39.3	25.	19.
53.	45.2	33.	22.2	17.7
38.	33.4	25.3	16.3	10.5

Tasmania.

(LINTHIA.) FAORINA.

Faorina GRAY, 1851, Ann. Mag. N. H.

This genus is at first glance most strikingly similar to Micraster. The lateral ambulacra are scarcely petaloid, slightly sunken, the groove extending to the ambitus, and even beyond; anterior ambulacral furrow slight. Peripetalous fasciole often dividing into two anterior circumscribed areas; short anal fasciole. Actinal surface convex. Median vertical ambulacral and interambulacral sutures bare. Apical system anterior; vertex central.

Faorina chinensis

! **Faorina chinensis** GRAY, 1851, Ann. Mag. N. H., VII. p. 132.

Pl. XIX^a. f. 4–6.

Nearly simultaneous with Gray's description of this species, the affinities of Tripylus were made the subject of an interesting paper by Troschel, to which I referred when speaking of the distinction of several genera established among the Brissina.

The outline from above is broadly heart-shaped, truncated at the posterior extremity. The longitudinal diameter is but slightly longer than the transverse. The test is high, somewhat conical; the vertex is central, placed immediately behind the apical system. The ambulacral petals are deeply sunken within the peripetalous fasciole; the depression of the lateral ambulacra is continued to the ambitus as a gradually diminishing groove, made somewhat prominent, owing to the great height of the outer edges of the ambulacral and interambulacral plates, and the fact that the vertical sutures of the plates of the median ambulacrum and interambulacrum are left bare. The anterior groove is well marked, and extends to the actinostome. The pores of the anterior ambulacrum are reduced to diminutive pores placed close together, near the apical system, gradually becoming more distant towards the ambitus, where the ambulacral plates are greatly elongated. The lateral petals are straight; poriferous zones indistinct at first, but after the fourth or fifth pair of pores the poriferous zone is broad, well defined; the two zones running nearly parallel; the pores are distinct, not conjugate, terminating abruptly and widely open at the peripetalous fasciole. The poriferous zones are broader than the median interporiferous space. The

anterior petals are about a third longer than the posterior. The peripetalous fasciole follows tolerably the general outline of the test; in the anterior part of the test it is double, forming across the anterior ambulacrum, between the two anterior petals, an elongated, irregularly crescent-shaped area; this fasciole is broadest at the extremity of the petals. Troschel says there are three genital openings; in four of the specimens I have examined there were only two, showing conclusively, what has already been insisted upon in other Spatangoid genera, that the number of genital openings is not a structural feature of generic importance, as has been assumed. The anal system is at the upper part of the vertically truncated extremity; it is elliptical, but slightly higher than broad, covered by one outer row of large polygonal plates, enclosing a nearly circular area, covered by much smaller plates, in the centre of which the anus is placed. The actinal surface is convex; the actinostome is situated near the anterior extremity; it has a very projecting posterior lip, high above the anterior lip. The actinal plastron is elongate, triangular, confluent with the posterior extremity, covered by a close tuberculation, becoming smaller and more crowded towards the posterior extremity. The posterior ambulacra form broad, bare avenues near the actinostome, extending nearly to the posterior edge, but becoming gradually concealed by the increasing number of tubercles carried by the ambulacral plates. The anterior ambulacra are covered by large distant tubercles, like those of the interambulacral area, diminishing in size and distance towards the ambitus. Along the median line, in the two anterior ambulacra, the vertical sutures are left bare a short distance from the mouth. A very slender subanal fasciole extends below the anal system from the ambitus to the level of the lower side of the anal system, reaching across the outer interambulacral line into the edge of the adjoining ambulacral field. The bare median interambulacral sutures are especially prominent in the abactinal part of the test; the posterior median interambulacral line extending along the edge of the test, from the apical system to the anal system, is frequently as prominent as the bare spaces, in continuation of the ambulacral petals. The bare spaces become indistinct towards the ambitus, with the exception of the posterior median line, which is directly connected with the broad bare avenues of the actinal surface. From the ambitus to the peripetalous fasciole the tubercles are nearly uniform in size, crenulate, perforate, diminishing slightly in size towards the fasciole, rather distant; miliaries indistinct, not numerous; the horizontal sutures of the plates are frequently left bare. Above the fas-

ciole the tubercles are larger adjoining the petals. The anterior part of the peripetalous fasciole seems to vary considerably in large specimens; we find sometimes two crescent-shaped areas, one above the other, or traces only of the second area. There are also more or less distinct narrow intrapetalous branches of the peripetalous fasciole, extending into the two anterior interambulacral spaces. The interporiferous space is covered by indistinct miliaries; the spines are short, cylindrical, at least those of the abactinal part of the test. The color of the dry tests is violet or grayish-violet. The anterior groove is covered by minute miliaries; the edge of the groove is flanked by distant tubercles, somewhat larger than those of the abactinal part of the test; the phyllodes round the mouth are wanting; only the two anterior actinal ambulacra form indistinct triangles, formed by the large pores diverging from the actinostome.

Long. Diam.	Trans. Diam.	Height.	Length Ant. Pair Amb. Pet.	Length Post. Pair Amb. Pet.	Dist. Mouth Ant. Edge.	Dist. Apical Syst. Ant. Edge.
65.5	59.	49.5	23.	18.5	9.2	23.
60.	53.	43.2	21.4	17.	9.	24.
52.	49.	40.	21.	15.	7.	20.

China.

SCHIZASTER.

Schizaster AGASS., 1836, Prod.
(See Part II. p. 363.)

Schizaster canaliferus

Echinus **lacunosus** LINN., 1758, Syst. Nat. 665.
! *Schizaster canaliferus*, AGASS., 1847, C. R. Ann. Sc. Nat., VIII. p. 20.

Pl. XXIII^a. f. 1–3; Pl. XXXIII. f. 7.

Outline heart-shaped; anterior extremity deeply indented at the edge by the broad, deep groove of the odd ambulacrum. The outline of the test, seen from above, is angular, slightly indented in the median anterior lateral ambulacral lines, broadest about opposite the central part of the test. The apical system is posterior, about one third the length of the test from the posterior edge. Seen in profile, the test rises rapidly from the anterior edge, attaining its greatest height at the vertex placed behind the apical system, thence the test curves rapidly to the upper edge of the posterior truncated extremity. The sides of the test are nearly vertical, high, rounded

towards the actinal and abactinal side. The edge increases in height in the same proportion with the increase in the height of the test. The posterior interambulacrum forms a rounded keel. In the middle of the plates of the posterior lateral interambulacra, near the upper part of the edge, there are two or three nodes, forming a disconnected keel, extending to the actinal surface.

The actinal surface is convex; the whole posterior extremity is rounded; the actinal side and the high posterior edge of the test running into each other, so as to form a continuous surface; the ambitus is only indifferently defined, in the anterior portion of the test. The anal system is placed in the upper part of the posterior extremity, which is slightly depressed, and slopes towards the posterior edge of the actinal plastron, forming a shallow depression between the two rounded nodes, which connect the actinal plastron with the posterior extremity of the test.

This species is remarkable for the great breadth and depth of the odd anterior ambulacrum. It forms a rectangular groove, attaining its greatest breadth a short distance from the apical system. The sides of the groove are vertical, slightly convex outwardly; the broadest part of the groove is about in the middle; where the peripetalous fasciole crosses this groove it is slightly narrower, shallower, becomes rounded, and is gradually lost at the actinostome; the pores are irregularly crowded, closely packed at the base of the angle of the vertical sides of the groove. The median (interambulacral) line forms a keel between the odd groove and the lateral anterior ambulacra, extending to the peripetalous fasciole, and continued as independent nodes to the edge of the actinal surface; a narrow, indistinct keel is formed nearer the groove which commences at the fasciole, consisting of two or three connected nodes.

The posterior lateral ambulacra are very short, petaloid, rounded at the extremity, with broad poriferous zones. The anterior lateral ambulacra are elongate, more sunken than the posterior, slightly broadest near the extremity, which flares outward; the pores are of the same size, elliptical, pointed, connected by a shallow groove. The abactinal extremity of the lateral ambulacra is narrow, pointed, with narrow poriferous zones; in the posterior ambulacra this rudimentary part is in the trend of the petals; in the anterior ones it forms nearly a right angle with the general trend of the ambulacra. The peripetalous fasciole crosses the posterior interambulacrum, pointing towards the posterior edge; it runs from the extremity of the posterior ambulacra, nearly parallel to the general trend of the anterior lateral ambulacra,

forming an outward angle near its extremity; it runs diagonally from the extremity of the lateral anterior ambulacra to the termination of the poriferous zone of the odd ambulacrum. The fasciole is broadest at the extremity of the anterior lateral ambulacra, and where it crosses (at right angles) the odd ambulacrum. The lateral fasciole is narrow; it commences from the angle of the posterior lateral interambulacra, runs diagonally across the test to the level of the lower edge of the anal system, where it descends rapidly, forming an angular loop below the anal system, the lower extremity of which nearly reaches the actinal plastron. The anal system is pointed, longitudinally elliptical; the whole of the abactinal surface is crowded by minute, uniform, secondary tubercles, with flat scrobicular circles; the edge of the anterior groove carries somewhat larger tubercles, and below the fasciole the tubercles of the anterior part of the test increase rapidly in size towards the ambitus, becoming larger and more distant as they approach the actinostome; the same is the case in the lateral posterior ambulacrum; the tubercles, however, increase more gradually, and on the posterior extremity they do not attain so great a size. The tubercles of the actinal plastron increase very gradually in size towards the actinostome from the posterior edge; they are closely arranged in rows, diverging, fan-like, from the posterior edge towards the actinostome, forming, at the same time, indistinct rows, diverging fan-like from the central line of the elongate actinal plastron, with its rounded sides, slightly narrower at the posterior extremity. The bare ambulacral avenues are narrow; the phyllodes not very prominent; the posterior lip of the actinostome raised, pointed, with a lip turned back.

The spines of the abactinal surface are short, slightly curved, somewhat club-shaped at the end, slightly longer on the edge of the petals, which they cover completely, and also reach across the deep, broad anterior groove. On the actinal side they increase in length in proportion to the size of the tubercles, forming a pointed tuft over the anal system, and two lateral tufts, on each side of the extremity of the actinal plastron. The spines at the extremity of the actinal plastron are cupped at the end.

The color of dried specimens is silver-gray. Usually two large genital openings.

Long. Diam.	Trans. Diam.	Height.	Length Ant. Lat. Amb. Pet.	Width Odd Ant. Amb.	Length Post. Lat. Amb. Pet.	Length Odd Pet. to Fasciole.	Width Actinal Plastron.	Dist. Ap. Syst. Post. Edge.
60.8	53.	38.3	24.2	9.9	10.	32.	20.	25.
68.6	56.5	45.	28.5	10.8	10.9	37.3	21.	25.2

Mediterranean.

Schizaster fragilis

! *Brissus* **fragilis** DÜB. o. KOR., 1844, Skand. Echin., p. 280.
! *Schizaster fragilis* AGASS., 1847, C. R. Ann. Sc. Nat., VIII. p. 22.
(See Part II. p. 363.)

Pl. XXI. f. 3; Pl. XXVI. f. 42.

Norway; Gulf of St. Lawrence; Straits of Florida.

Schizaster gibberulus

! *Schizaster* **gibberulus** AGASS., 1847, C. R. Ann. Sc. Nat., VIII. p. 22.

This seems to be a smaller species than S. canaliferus, judging from the specimens preserved in collections. It is difficult for want of material to make an accurate comparison of this species with the Mediterranean S. canaliferus, to which it is closely allied. It appears, however, to differ by its comparatively shorter lateral anterior ambulacra, the more anterior position of the apical system, the usual presence of three or four small genital openings, the more flattened and elongate (posteriorly) test, the vertically truncated posterior extremity, the proportionally coarser and more distant tubercles, and a deep re-entering angle of the fasciole in the lateral posterior interambulacral spaces.

Red Sea.

Schizaster Philippii

! *Tripylus* **Philippii** GRAY, 1851, Ann. Mag. N. H., VII. p. 132.
! *Schizaster Philippii* A. AGASS., 1872, Rev. Ech., Pt. I. p. 158.

Pl. XXVI. f. 40-41.

This species of Schizaster, which is closely allied to S. fragilis, and is its Southern representative, has been referred by Gray to Tripylus, on the same grounds which induced Sars to refer its northern congener to it. We know now, however, that the number of the genital openings alone is not a suitable generic distinction, and after Lütken's exhaustive comparison and analysis of the reasons for uniting T. fragilis to Schizaster, there is no necessity for further discussion of the question of the generic affinity of these two species.

Test depressed; outline from above broadly elliptical, with deep anterior indentation, made by the anterior ambulacral groove. Apical system slightly posterior, coincident with the vertex; greatest breadth across that part of the test. Anterior and posterior lateral petals slightly sunken; anterior not

quite twice as long as the posterior ones. The course of the petals much as in S. fragilis; the posterior, however, slightly arching towards the median posterior interambulacral line. Anterior groove shallower than in any other species of the genus; poriferous zones distinct; but interporiferous space quite narrow; edges of groove very gradually rounded towards the sides, not forming a sharp keel, due to the great depression of this part of the test, as in the other species of the genus. Owing to the greater length of the posterior petals, the posterior part of the peripetalous fasciole forms three sides of a rectangle; the posterior side, somewhat concave, runs at a slight angle with the anterior petal nearly to its extremity, crossing the point of the petals at an obtuse angle; the sides of the rectangle starting from the point where the lateral fasciole, which runs nearly parallel with the ambitus, branches off, and from the angle formed in the median anterior interambulacral space, which is somewhat nearer the apex than the extremity of the petal. The lateral fasciole curves towards the posterior extremity, sloping gradually towards the ambitus, passing below the anal system at the very edge of the test. The proportions of the anal system are nearly those of S. fragilis; the large plates which cover it are, however, more numerous, and decrease quite gradually in size towards the anal opening; there are in S. fragilis only two or three rows of large plates surrounding a number of comparatively much smaller ones, immediately round the anus. The tuberculation of this species is comparatively coarser, and the tubercles more distant than in its Arctic representative. The large tubercles on the rounded edges of the anterior ambulacral groove are widely separated, when compared to the close arrangement of the corresponding tubercles in S. fragilis. The actinostome is much broader (transverse), compared to its longitudinal diameter, than in S. fragilis. The general coloration of the two species is similar, judging from dried and alcoholic specimens. The Antarctic species is probably darker.

Long. Diam.	Tran Diam.	Length Ant. Lat. Amb. Pet.	Length Post. Amb. Pet.	Breadth Odd Ant. Amb.	Height.	Dist. Apical Syst. Post. Edge.
65.5	64.	5.1	17.5	32	35.	32.5

Patagonia.

Schizaster ventricosus

! *Schizaster* **ventricosus** GRAY, 1851, Ann. Mag. N. H., VII. p. 133.

This species is intermediate between the species of the group of the genus to which S. fragilis and S. Philippii belong and that formed by S. canaliferus and S. gibberulus. It has the comparatively elliptical outline and subcentral apical system of the former, with the more deeply sunken lateral ambulacra, broad anterior groove, the angular peripetalous fasciole, and the four genital openings of the latter group.

Test thin; outline from above broadly elliptical, angular anteriorly. Apical system subcentral, posterior; vertex immediately behind the apical system, which is situated in the flat sloping space formed by the spreading of the median abactinal part of the interambulacra, which narrow the abactinal part of the petals almost to a point, forming a slight angle with the general direction of the lateral petals, as in S. canaliferus and S. gibberulus. The two posterior genital openings are large, round; the anterior small, forming an irregular rectangle. The posterior petals are concave outwardly; the anterior only arch outwardly at the extremity. This species is remarkable for the great breadth of the lateral ambulacra. The odd anterior ambulacrum is placed in a deep, flat, rectangular groove, with steep sides, forming a high keel in the median anterior interambulacral space, extending nearly from the apex to the peripetalous fasciole, where the keel is lost. The peripetalous fasciole is broad, angular, extremely broad at the extremity of the anterior lateral petals, re-entering in the median interambulacral spaces.

The broad posterior extremity is nearly vertically truncated, forming a broad, flat, posterior extremity, in which is placed the comparatively small anal system, covered by plates decreasing uniformly towards the anal opening. The lateral fasciole runs obliquely to the ambitus from the middle of the anterior ambulacra towards the posterior extremity. The posterior extremity of the actinal plastron is lost in the rounded posterior edge of the test. The tuberculation within the peripetalous fasciole is coarse, closely packed in all the interambulacral spaces, except the odd posterior one.

Long. Diam.	Trans. Diam.	Height.	Dist. Ap. Syst. Post. Edge.	Length Post. Lat. Amb. Pet.	Length Ant. Lat. Amb. Pet.	Width Ant Odd Amb.
69.	60.	43.	32.	16.	27.5	8.

Feejee Islands; Philippine Islands; Siam.

MOIRA.

Moera (**Mich.**), 1855, non LEACH nec HÜBN.
Moira A. AG., 1872, Rev. Ech., Pt. I. p. 146.
(See Part II. p. 365.)

Moira atropos

! *Spatangus* **atropos** LAMK., 1816, An. s. Vert.
! **Moira** *atropos* A. AG., 1872, Rev. Ech., Pt. I. p. 146.
(See Part II. p. 365.)

Pl. XXIII.

West Indies; North and South Carolina.

Moira clotho

! *Moera* **clotho** MICH., 1855, Rev. Mag. Zoöl.
! **Moira** *clotho* A. AG., 1872, Rev. Ech., Pt. I. p. 147.

There are, in the Jardin des Plantes, and in the collection of Michelin, now in the École des Mines, specimens of a species of Moira most closely allied to the West Indian Moira atropos; this, and Hipponöe depressa, are the two species of Echini from the two sides of the Isthmus of Panama, which it is most difficult to discriminate satisfactorily, and for which more abundant material is needed for an accurate comparison. The points of difference consist in the different positions of the apical system, which is more central in the California species; the shorter longitudinal diameter compared to the transverse, and, consequently, the broader and comparatively larger actinal plastron; the greater size of the actinostome, and the smaller anal system, which is more circular, only pointed at the lower extremity. These are characters which, as far as the material from the East Coast can furnish any data, appear tolerably uniform in the specimens I have had to examine and compare from different localities.

Gulf of California.

Moira stygia

! *Moera* **stygia** LÜTK., 1872, in A. AG., Bull. M. C. Z., III.
! **Moira** *stygia*, A. AG., 1872, Rev. Ech., Pt. I. p. 147.

This is a most characteristic species, and at once distinguished from its congeners by striking features. The test is remarkable for its great height, its general conical form, and the sharp, slightly rounded posterior keel, extending from the vertex to above the anal system, — the vertex is about halfway to the posterior edge from the apex, along the arched keel, — its elon-

gate apical system, its steep sloping anterior extremity. On the actinal side the actinal plastron is rounded posteriorly, projecting into a sharp beak. The sunken ambulacra are narrow; the edges slope suddenly, and are not gradually curved in, as in the other species of the genus. The posterior ambulacra are straight, proportionally larger; the course of the anterior pair forms but a slight angle near the apex; the posterior edge, which projects over the lateral anterior ambulacra in M. atropos, and which is more than one third the length of the whole ambulacral depression, is, in this species, scarcely one fifth of the length of the corresponding petal. In the odd anterior ambulacrum the triangular space dividing, in M. atropos, the groove into two cavities, is here reduced to a very indistinct space (lip), forming gradually sloping sides, slightly re-entering in the centre, extending to the extremity of the petal, which terminates at a considerable distance above the ambitus, the ambulacral groove disappears very gradually, becoming a slight indentation at the ambitus, while it is quite deep, and extends to the actinostome, in M. atropos.

The outline of the test, as seen from the actinal side, is broadly rounded anteriorly, pointed posteriorly. The actinostome is remarkably large, nearly twice as broad, in proportion to its length, as in M. atropos. The actinal plastron is elongate, rounded towards the posterior extremity, which terminates in a sharp keel. It is covered by a uniform tuberculation of large tubercles, scarcely becoming smaller at the posterior end; while, in M. atropos, the diminution in the size of the tubercles is quite rapid and marked, as the distance from the actinostome increases. The anal system is very elongated, narrow, elliptical; but the general arrangement of the plates is the same,— an outer row of large plates, of nearly uniform size, surrounding a circular area of smaller irregular plates in which the anal opening is placed. The course of the lateral fasciole is nearly horizontal, forming a sharp curve as it passes towards the anal system to become the anal fasciole; it extends far below the anal system to the edge of the test, to a short distance above the beak of the actinal plastron. In the specimens examined the tuberculation of the abactinal surface is somewhat more crowded and proportionally smaller than in M. atropos. A comparison of the measurements of this species with those of M. atropos will show at a glance the great differences between them.

Long. Diam.	Trans. Diam.	Height.	Dist. Apical Syst. Ant. Edge.	Length Ant. Lat. Amb. Pet.	Dist. of Ant. Amb. from Apex.	Length Post. Amb. Pet.	Height Anal Syst. above Edge.
49.5	43.	40.	28.	28.	4.	17.	16.

Red Sea; Zanzibar.

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* For Synonymes see Synonymic Index, Part I. p. 171.

ERRATA.

PARTS I., II.

In CHRONOLOGICAL LIST, page 71, insert in **1858**,

McCRADY, J., Proc. Elliot Soc. N. H. of Charleston, S. C., I. p. 283, 1858, **Ravenelia**.

In **1860**,

EBRAY, Étud. Pal sur le Dépt. de la Nièvre, p. 56, 1860, **Orbigniana**.

Page 77, 3d line from bottom, for **Ravenellia** read *Ravenellia* (**Lütk.**) non McCR. 1858.
" 128, 9th line from bottom, for *Evechinus* VERRILL read **Evechinus** VERRILL.
" 131, insert 4th line from bottom, *Goniocidaris tubaria* ! LÜTK. 1864. Bid.
" 139, 3d line from top, for **Lovenia** AGASS. read **Lovenia** DES. 1847 in AGASS.
" 143, 21st line from bottom, for **Mespilia** AGASS. read **Mespilia** DES. 1846 in AGASS.
" 164, 25th line from bottom, for *Strongylocentrotus lividus* read **Strongylocentrotus** *lividus*.
" 194, 19th line from bottom, insert **Orbigniana** EBRAY, 1860.
" 197, 15th line from top, for **Ravenellia** LÜTK. 1864 read **Ravenelia** McCR. 1858.
Ravenellia (**Lütk.**) 1864, non McCR.
" 213, 19th line from bottom, for *Goniocidaris canalicuta* read ...... *canaliculata*.
" 216, 20th line from top, for *Echinus elegans* DUB. o. KOR. read *Echinus elegans* (**Dub. o. Kor.**)
" 217, 6th line from bottom, for **Scaphechinus mirabilis** A. AG. read ...... **mirabilis** BARN.
" 219, 4th line from top, for **EUSPATANGINA** A. AG. read **SPATANGINA** GRAY.
" 242, to list of genera in Plate *D* add ECHINOTHRIX.
" " " " " " *E* " METALIA.
" 254, 18th line from bottom, insert *Orthocidaris* (**A. Ag.**) 1863, non COTTEAU, 1862.
" 267, 17th line from bottom, for ! *Coelopleurus* **floridanus** A. AG. 1869, read ...... 1872.
" 286, 2d line from top, for ! **Gonocidaris maculatus** read ...... **maculata**.
" 297, 17th line from bottom, for **Toxopneustes** AGASS. 1836. Prod. read ...... AGASS. 1841, Mon. Scut. Int.
" 306, 4th line from top, for **Clypeaster** LAMK. 1816, read *Clypeaster* LAMK. 1801.
" 311, 13th line from top, for ! **Clypeaster** *rosaceus* LAMK. 1816, read ...... LAMK. 1801.
" 344, 2d line from top, for **Spatangidae** AGASS. 1841, read ...... AGASS. 1836.
" 347, under original name **Homolampas** add *Lissonotus* (**A. Ag.**) 1869, non SCHÖN.
" 365, 2d line from top, insert *Moera* (**Mich.**) 1855, non LEACH nec HUEBN.

ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. VII.

REVISION OF THE ECHINI.

BY

ALEXANDER AGASSIZ.

PART IV.

UNIVERSITY PRESS, CAMBRIDGE,
WELCH, BIGELOW, & CO.
1874.

PART IV.

STRUCTURE AND EMBRYOLOGY

OF THE

ECHINI.

WITH SEVENTEEN PLATES ISSUED WITH PART III., AND SIXTY-NINE WOOD-CUTS PRINTED IN THE TEXT.

CONTENTS.

NOTE TO PART IV.

THE lithographic stones of six plates, containing the anatomy of Strongylocentrotus Dröbachiensis and of Echinarachnius parma, were destroyed, together with the original drawings, and the bulk of my notes on the subject, in the great conflagration of November 9, 1872. They were the accumulation of several years of more or less consecutive work on living specimens of the two more common species of the New England coast. My observations on S. Dröbachiensis and Echinarachnius parma were intended as the basis of a critical revision of many of the doubtful points of the anatomy of the order, and at the same time, taking these two species as types of their allies, I hoped to give as complete a history as possible of the structure of two of the suborders of the Echini. This, in connection with the anatomy of Spatangus, lately published by Hoffman, would have given us a tolerably full account of the whole order.

This exposition I must now leave for future special monographs, and I here add a revision of the Anatomy and Embryology of the order, based upon what I have myself observed, taking in turn each of the three suborders, in the discussion of the special points of structure. It will of course be impossible for me, on account of the loss of so many of my plates of reference, to make Part IV. as complete as it would otherwise have been, and I am compelled to print a much less satisfactory exposition of this part of the subject than I hoped to be able to publish.

ALEXANDER AGASSIZ.

CAMBRIDGE, January, 1874.

TERMINOLOGY.

The following terms are usually employed in the description of the species. A few additional terms, not of such general application, are also used; they will be found explained in their proper places.

The test of a Sea-urchin is composed of the following parts. An apical system, or, as it is also called, an abactinal system (*Pl. II^b. f. 1, 6; III. f. 11*), composed of the anal system (*Pl. VII. f. 18*), the genital and the ocular plates; the genital plates correspond to the summit of the interambulacral areas, the ocular plates to the ambulacral areas. One of the genital plates is spongy, pierced with small holes, and is called the madreporic body (*Pl. II^b. f. 1, 6*). The anal system is not necessarily a part of the apical system (*Pl. XV. f. 7*). The coronal system, or test proper, is made up of ten zones, five ambulacral and five interambulacral areas (*Pl. VI^a. f. 1, 2*). The ambulacral areas consist of a median zone (*Pl. VII. f. 4*), carrying the tubercles, and are either flanked by a poriferous zone or pierced for the passage of the suckers. The pores are called unigeminal, bigeminal, trigeminal, when they are arranged in single, double, or triple pairs of pores. When the pores form an uninterrupted line from the apex to the mouth they are called simple; they are called petaloid when near the apex they expand and afterwards contract, forming a leaf-like figure on the upper part of the coronal system (*Pl. XI^b. f. 1*). The interambulacral area consists of two vertical rows of plates extending from the apex to the mouth (*Pl. VII. f. 14, 16*). The actinal system or peristome is the opening closed by a membrane, in which the mouth (actinostome) is situated (*Pl. II^b. f. 2; Pl. VII. f. 20*).

The actinal system is, according to its shape and position, circular, central, and notched, or eccentric, elliptical, transverse, and bilabiate. The poriferous zone frequently assumes a peculiar shape round the actinostome, becoming petaloid in some of the regular Echini (*Pl. XIV^b. f. 1*); in others, where the actinostome is pentagonal (Cassidulidae), the two poriferous zones are separated by the spreading of the ambulacral area, forming what is called a floscelle; adjoining actinal ambulacral parts (called the phyllodes) are separated by an accumulation of small tubercles called bourrelets (*Pl. XV. f. 3, 6*), which correspond to the interambulacral region.

The tubercles attached to the plates composing the test are divided, according to their importance, into primary tubercles, secondary tubercles, miliary tubercles, and granules. We distinguish in the primary tubercles a mamelon which may be perforate (*Pl. II. f. 1*), or imperforate (*Pl. III. f. 11*); the boss is the conical or mammillary eminence supporting the mamelon, which may be either smooth (*Pl. III. f. 3*), or crenulated (*Pl. II^b. f. 6; Pl. III. f. 11*).

The areola or scrobicule is the smooth circular or elliptical space from which the boss rises (*Pl. III. f. 3*).

The scrobicular circle is the raised ring of small tubercles enclosing this areola (*Pl. III. f. 3*).

Miliary zones are spaces between any two rows of primary tubercles, either in the ambulacral or interambulacral region, which may or may not be covered by small granules (*Pl. III. f. 3*).

Sutural impressions are the smooth zones or furrows which mark the junction of adjoining coronal plates (*Pl. VIII. f. 22, 26*).

Angular or sutural pores are found in the horizontal and median ambulacral or interambulacral lines of junction of coronal plates. Radioles or spines (*Pls. I^c., I^e.*) are the appendages articulating upon the tubercles. The different parts of the spines are the socket by which it is articulated to the tubercles; the lower part of the radiole is called the head, and is separated from the neck, which is usually smooth or finely striated, by the milled ring, — a prominent ridge more or less deeply grooved, serving as an attachment for the muscles which are to move the spine; beyond the neck we have the body or shaft of the spine.

The principal parts of the jaws (*Pl. II^a., Pl. XI^a.*) are the five pyramids in which the teeth proper move. The auricles (*Pl. II^b. f. 5, 10*) are the limestone pieces of the interior of the test, intended for the support of the whole dental apparatus (lantern of Aristotle).

Fascioles or semitæ — apparently smooth bands, but really covered by minute modified spines — are found only in Spatangoids, and will be described in their appropriate places.

In Clypeastroids and Spatangoids, owing to the presence of a well-defined longitudinal axis, we distinguish a bivium and a trivium. The bivium is made up of the two posterior lateral ambulacra with the enclosed interambulacral space. The trivium is the combination of the three anterior ambulacra. We also distinguish anterior and posterior lateral ambulacra, an odd anterior ambulacrum, and an odd posterior interambulacrum.

Pedicellariæ are modified spines (*Pls. XXIV. – XXVI.*).

THE TEST.

THE composition of the test in the three suborders of recent Echini is readily reduced to a common formula, and, indeed, from an analysis of the plates of the test alone we should hardly find sufficient data for a correct discrimination of the suborders. The Desmosticha stand in marked contrast to the other orders, owing to the large number of nearly identical coronal plates which compose the test in the interambulacral space, extending from the actinostome to the apical system (*Pl. VI^a. f. 1, 2*); in the ambulacral space the arrangement of the plates is much more irregular; certain numbers of plates form series, which are nearly repeated in vertical succession. The plates of the ambulacral system are much more numerous in the Desmosticha than those of the interambulacral spaces (*Pl. VII. f. 4*), and in all Desmosticha the test is more or less spherical, flattened, with a sort of ventral surface (*Pl. VI^a. f. 1*) (the actinal surface), which forms an indistinct passage at the ambitus (the edge of the test) to the dorsal side (the abactinal side). In some of the regular Echini this passage is so gradual that no ambitus proper can be said to exist (Amblypneustes, *Pl. VIII^c.*); while in others, such as Colobocentrotus (*Pl. III^d. f. 5*), some species of Pseudoboletia and Arbacia, the contrast between the actinal and the abactinal side of the test is very distinctly marked by the flattening of the test and the sharply defined ambitus.

In the Clypeastroids (*Pl. XI^b. f. 1*) the number of the coronal interambulacral plates is much smaller than in the Desmosticha; the plates are of very variable outline, the test being as it were built up of individual plates fitted especially for their place. This specialization of the coronal plates is carried to the greatest perfection in Petalosticha, and in some of the Brissina (*Pl. XXII.*), Schizaster, and Moira (*Pl. XXIII.*), and the like, the shape of the plates is widely different in different parts of the test. In Clypeastroids we find the greatest contrast between the actinal and abactinal side (*Pl. XII^c. f. 3, 4*), — a contrast that extends not only to the shape of the plates of both the ambulacral and interambulacral areas, but to the intimate structure of these two areas. The ambitus is well marked by a sharp edge; the growth

of the two surfaces proceeds independently after reaching a certain size; the character of the spines of the two surfaces is usually different; but the most marked difference exists in the structure of the ambulacral system, which forms in all Clypeastroids ambulacral furrows, ramifying more or less over the actinal surface, the thin, delicate water-tubes of which are in striking contrast to the comparatively powerful ambulacral tentacles of the abactinal surface. As in the Petalosticha the number of ambulacral plates of the Clypeastroids is greatly reduced on the actinal side, and immediately below the petals they do not exceed in number the interambulacral plates. The interambulacra do not extend to the actinostome, but the ambulacral plates encroach upon them, forming what has been called the buccal rosette, immediately round the mouth (*Pl. XII^c. f. 4*); this rosette consists of ambulacral plates, it precedes the interambulacral area, commencing with a single plate. The contrast between the actinal and abactinal side is not so sharply marked in Fibularia and the Echinanthidae (*Pl. XI^b.*) as in the Scutellidae (*Pl. XII^c.*), Laganidae, and the like, in which the most characteristic structural features of the suborders are fully developed. There are in the Clypeastroids but few variations in the structure of the abactinal part of the ambulacral system. The great structural distinctions are mainly found on the actinal side.

In the Petalosticha the specialization of the interambulacral plates is carried to its height. The actinostome also presents some very characteristic differences; the outline formed by the edge of the test is subject to considerable changes (*Pls. XV., XVII., XXI., XXIII., XXIII^a.*). In the other suborders, especially in the Clypeastroids, the uniformity of the actinal opening is very marked. The Petalosticha are distinguished from the Clypeastroids by the formation of plastrons (*Pls. XXI. f. 4, 5; XXI^a. f. 5*) where the tuberculation is usually closely packed, often surrounded by bands formed of minute miliaries (the fascioles); but what is especially characteristic of this suborder are the remarkable changes to which the abactinal part of the ambulacral system is subject in the different families, and the specialization of one of the ambulacra, which in many genera shows a completely different structure from that of the lateral ambulacra (*Pl. XV^a. f. 1, 7; XIX^a., XIX^b., XXI^c., XXIII^a.*). The tubercles which form so conspicuous a part of the test of the regular Echini, as in the case of the Cidaridae (*Pl. II. f. 1*), where they are limited in number and very large, are gradually reduced in importance as we pass through the Diadematidae (*Pl. III.^{a}, III^b.*) to the Echinidae (*Pl. VIII^b., VIII^c.*), until in the Clypeastroids (*Pl. XI^e*) they are

extremely numerous, small, and though not differing in structure from those of the regular Echini, yet are comparatively unimportant, and become still less important in the Spatangoids, where in many places of the test the tuberculation is reduced to a mere granulation (*Pl. XV^a., XXI^a.*). In a few genera of the three suborders, we sometimes find the scrobicular circles deeply sunken, as, for instance, in Asthenosoma, where the miliary tubercles are surrounded by a deep channel, formed by the scrobicular circles. In many Clypeastroids the scrobicular circles of the primaries are sunken; in Echinonëus (*Pl. XIV^a.*), and in some Spatangoid genera, — Breynia (*Pl. XV^a. f. 7*), for instance, — where a few of the large tubercles within the peripetalous fasciole have a similar structure. The large abactinal tubercles of Maretia and Lovenia have a sunken scrobicular area; but in Lovenia this is carried to such an extent that the depression forms a purse on the interior of the test (*Pl. XXXVIII. f. 28*). The calcareous test is covered by a thin cuticle, crowded with vibratile cilia; in the folds of the envelope and of the intestine and other organs the plates forming the test, and the spicules found in the walls of the intestine, are deposited (*Pl. XXXVIII.*). These spicules are not found in the Petalosticha.

The ambulacral system forms, in the Clypeastroids (*Pl. XI^b. f. 1*) and Petalosticha (*Pl. XXIII. f. 5*), a bivium and a trivium. In the Clypeastroids the ambulacra have all the same structure (*Pl. XI^c. f. 2*), with the exception of differences of length in the petals (*Pl. XII^c. f. 3*), and of the lunules, placed in the prolongation of the petals, which are more or less well developed in the different ambulacra, and are not materially different (*Pl. XII^d. f. 3*). The odd anterior ambulacrum forms, in connection with the anterior lateral ambulacra, a trivium, in which the lateral anterior interambulacra are placed symmetrically on each side of the median longitudinal axis, and there is one odd median ambulacrum (*Pl. XII^d. f. 3*). In the bivium, on the contrary, the lateral posterior ambulacra are placed symmetrically on the sides of the median longitudinal axis, and there is an odd median interambulacrum (*Pl. XII^d. f. 3*). In Petalosticha the symmetrical combinations possible in the trivium are complicated by the difference in structure of the odd anterior ambulacral zone (*Pl. XV. f. 2; Pl. XXI. f. 5*). It is, as I have attempted to show, impossible to trace a bivium and a trivium in the Desmosticha which will be homologous to that of the Petalosticha and Clypeastroids, as there is no anterior or posterior developed; what appears to be the first trace of this in the regular Echini, the differentiation of a longitudinal

and of a transverse axis in Echinometradae, owing to the obliquity of the test, is an embryonic feature retained in the Echinometradae, and which exists in all Echinoderms in their Pluteus stage. In one genus of the Echinometradae (*Pl. X^a. f. 2*) the short axis makes an acute angle with the longer axis; in another it is the reverse (*Pl. III^c. f. 1*). In Stomopneustes the obliquity is so slight as to be imperceptible in many specimens.

Lovén has made an exceedingly ingenious analysis of the test of the three suborders of Echini, in which he attempts, on entirely new grounds, to determine the position of the madreporic body as the right anterior one in the regular Echini. From what I have attempted to show of the position of the madreporic body with reference to an axis determined by the course of the alimentary canal, I think Lovén's views cannot be sustained. The homology he traces in the arrangement of the peristomal plates is one which is due to the nature of the case. Any series of plates with an angular suture alternating on each side of a median line, and increasing in number at the apical extremity in a spiral order, must necessarily consist of alternately larger and smaller ones, and the unequal rate of growth, as well as its complete independence in the ambulacral and interambulacral plates, to which I called attention in the Preliminary Report on the Florida Deep-Sea Echini, seems to me to form strong reasons for objecting to the general laws Lovén attempts to deduce from them. The Clypeastridae, standing, as they do, intermediately between the regular Echini and the Spatangoids, do not come strictly within the scope of the ordinal arrangement by which he has so ingeniously connected the Spatangoids with the Desmosticha; as in them (the Clypeastridae) neither the connection of the madreporic body with the right anterior genital plates ever exists, nor do we find the interambulacral spaces in many genera reaching the actinostome, which is entirely surrounded by ambulacral plates, while the interambulacral plates commence with a single irregularly shaped plate, entirely outside the peristomal ring of the ambulacral plates.

GROWTH OF NEW PLATES.

In the Spatangoids and Clypeastroids the pores are never arranged in arcs; the ambulacral plates are limited to their simplest expression, — a series of single plates arranged symmetrically on the two sides of a median axis; each plate is perforated, either with one or two pores, to carry only a single tentacle. We find in these suborders no difficulty in understanding the mode of increase of the ambulacral areas. Additional plates are constantly added at the apical pole, which push down, towards the actinostome, the older, previously formed plates (*Pl. XI.*, *Pl. XII.*). The growth of the upper part of the ambulacral system above takes place independently of the increase in number of the plates of the interambulacral areas. At the actinal end of the ambulacral system the same phenomenon of independent growth takes place by the crowding together of the ambulacral plates to form phyllodes. The intermediate parts of the ambulacral system between the phyllodes and the petals retain their relations to the adjoining interambulacral plates during their growth, as the number of new ambulacral plates formed is small compared to that added at the apical system to form the petals. So that in the Clypeastroids, as well as in the Petalosticha, the number of plates in the two areas increases independently, but only at the abactinal system; the plates increasing in size round the edges as fast as required by the increase in diameter of the test. Plates of both systems are constantly passing from the region above the ambitus to the actinal surface, the periphery not being a constant one even in the flat Scutellidae.

In the Echinonidae the same simple mode of independent increase of the plates of the two systems is observed. In the Desmosticha, the Cidaridae alone have the same simple mode of growth, and, owing to the small number of plates of the interambulacral area, the growth of the ambulacral system is plainly shown to be entirely disconnected from that of the interambulacral system; new plates are constantly formed at the abactinal extremity of the two areas immediately adjoining the genital plates (*Pl. VI. f. 21*). In many genera, even in the adult, the abactinal part of the ambulacral system

always exhibits its simple mode of growth, as in several of the fossil genera allied to Phymosoma and the like. In Arbacia the ambulacral plates above the ambitus are simple; those of the actinal surface are crowded out of their original position and become arranged in arcs. In the Diadematidae (*Pl. VI. f. 15^a*), Echinometradae (*Pl. IX.; Pl VI. f. 16^a*), and Echinidae (*Pl. VII.*), the younger stages always have simple single ambulacral plates, and it is from the study of the young that we have come to a correct understanding of the manner in which additional plates are intercalated, in the ambulacral series, at different points at the same time, by the splitting up of the original plates, and by the arrangement of adjoining primitive plates into more or less regular arcs of pores. In this way the ambulacral plates of the two sides of the median lateral line are apparently arranged into two sets, — one large perforated plate on each side of the suture which carries the primary tubercles, and a second outer set of minute perforated plates, which are arranged in more or less regular arcs, intercalated between the primary plates.

The position of these secondary plates is used to distinguish genera, but, unless taken from the mode of growth of the plates, the apparent arrangement of the pores is deceptive, and similar results are obtained by very different modes of growth, by combinations of parts of one arc with parts of a second arc. The simplest mode of intercalation of new plates is that of Echinus (*Pl. VI. f. 4*), in which a small triangular plate is developed between the two larger ones, and thus trigeminate simple arcs are formed. The same result is also reached in Hemipedina by the curving of the pores round the base of the primary ambulacral tubercles (*Pl. III. f. 4*), the tubercle riding upon two or three of the original plates, the sutures of which can be plainly seen running through its mammary boss. In Mespilia (*Pl. VI. f. 1*), Salmacis (*Pl. VI. f. 6*), Temnopleurus (*Pl. VI. f. 5*), Toxopneustes (*Pl. VI. f. 23, 24*), and Evechinus (*Pl. VI. f. 30*), the same mode of growth occurs as in Echinus. It is very similar in Phymosoma (*Pl. VI. f. 2*) and in Diadema (*Pl. VI. f. 15*). In one of the groups of the Echinidae, Amblypneustes (*Pl. VI. f. 26, 27*), Holopneustes (*Pl. VI. f. 25, 25^a*), and Hipponöe (*Pl. VI. f. 28, 29*), the original mode of growth is identical with that of Echinus; but in the subsequent development, owing to the great number of plates which are rapidly added, more or less regular vertical rows or irregular trigeminate arcs are formed, due to the lateral crowding of the secondary plates.

In the Echinometradae the primary plates always retain their greater com-

parative size; the secondary plates are added either above, below, or laterally. In Strongylocentrotus they are added on the sides, new plates being constantly intercalated between the upper secondary plate and the large primary plate (*Pl. VI. f. 7 – 10*), so as to form arcs varying in the number of pores at different stages of growth. In Stomopneustes there are several sets of secondary plates forming trigeminate arcs added on the side of the large primary plate (*Pl. VI. f. 11, 11*[a]). In Echinometra (*Pl. VI. f. 12*), the number of secondary plates is smaller than in Strongylocentrotus; the mode of growth is the same. In Parasalenia (*Pl. VI. f. 14*), the arcs round the base of the primary tubercles are formed by a combination of the structure of Arbacia and Echinometra. In Heterocentrotus (*Pl. VI. f. 12*), the arc, made up of numerous pores, sometimes as many as thirteen, consists of small secondary plates. In Sphaerechinus (*Pl. VI. f. 16 – 19*) and Echinostrephus, the formation of the arcs of pores resembles most closely Echinometra.

PERISCHOECHINIDAE.

Isolated plates of Sea-urchins, referred formerly to the genus Cidaris, have been known for a long time from the Silurian, Devonian, and Carboniferous. Owing to their peculiar shape and the character of their tuberculation, they were separated from Cidaris as Echinocrinus by Agassiz, and subsequently placed by him in the vicinity of Cidaris. McCoy, in his Carboniferous Fossils of Ireland, was the first to describe tolerably complete specimens and to throw new light on their affinities.

A number of genera of this group have been discovered in America and Europe; the affinities of the group of Echinoderms comprising Melonites, Archaeocidaris, Eocidaris, Palaechinus, etc., have been the subject of much discussion, from the time of their first discovery, when they were considered as true Echini, till McCoy proposed to consider them as a distinct order, equivalent to the Echini, under the name of Perischoechinidae.* Roemer considered them a suborder † of Echini, and Desor ‡ a tribe, to which he gave the name of Tessellés, while formerly Professor Agassiz, on theoretical grounds alone, and before the structure of this group had been as well marked out as it is at present, considered them as belonging to Crinoids. Since the publication of these views a considerable number of more or less perfect specimens have been found, until it is now possible to reconstruct the characteristic features of this type of Echinoderms; the comparison with the recent genera of Cidaris has shown points of identity which will, I think, place beyond doubt the true nature of these apparently anomalous Echinoderms, and show plainly that their systematic position is that of a suborder among Echini, as first correctly appreciated by Roemer. Before the discovery of the oral and abactinal openings the presence of a large number of plates in the interambulacral space seemed to relate them to the Cystidae, where we find hexagonal, pentagonal, and other irregularly shaped plates, many of which are perforated; but, as Müller has clearly shown, their pores cannot be homologized with those of the true Echini, being openings corre-

* Brit. Palaeozoic Fossils, p. 124.

† Wieg. Archiv., 1855, p. 312.

‡ Synopsis d. Echinides Foss., 1858, p. 152.

sponding to those which we might find in the plates of the abactinal area. From the moment the presence of teeth was clearly proved, and the existence of a large oral opening demonstrated, placed opposite an anal region, surrounded by plates entirely homologous to those of the ovarian and ocular plates of the Echini, their affinity to Crinoids could no longer be maintained; as we find nothing in any Crinoids thus far known which could in a remote degree be homologized with those areas, as constructed in the group of Palaechinidae. There remained, therefore, nothing but to place them among Echinidae, and this view is now generally adopted; the value of the characters of the group, whether ordinal or subordinal, being the only ones questioned. No writer thus far has as yet succeeded in homologizing these Echini with our recent Echini; the structure of the ambulacral and interambulacral system finding no parallel apparently in any of the recent Echini. Müller, while establishing the genus Lepidocentrus,* took occasion, in the course of his description of the isolated plates and spines which were found in the Eifel, to show that it was possible for Echini to have such imbricating scales as we find in Lepidocentrus, stating, however, at the same time, that there exists nothing of the sort in the recent Echini; the only irregularly shaped plates known are those of the actinal system of Cidaris, with which, however, he considers they have nothing in common. Müller was the first to draw attention to the value of this set of plates in distinguishing the Cidaridae from the Echini, but he has not, I think, fully appreciated the value of this part of the actinal system of the family. It is well known that the Cidaridae and Echinothuriae have no cuts in the test for the passage of the actinal gills, but we find these cuts directly at the point of contact of the buccal membrane and the teeth, and *there the gills make their appearance.* Müller himself has *drawn these cuts* in his plate,† in the very memoir where he denies the existence of the gills, and it is somewhat astonishing they should have escaped the notice of such an admirable observer. It is well known that in the Cidaridae we have only a small number of coronal plates; in the largest Cidaris I have ever seen (Phyllacanthus gigantea), measuring 2.5 inches in height and 3.5 in diameter, there are only ten. If we examine a young Cidaris, we find the coronal plates reduced to a minimum, but, contrary to what is the case in young Echini (Strongylocentrotus) of the same age, where no buccal membrane is developed,‡ we already find the buccal

* Lepidocentrus of Müller, which has thus far escaped the attention of American Paleontologists, is closely allied to Lepidechinus of Hall, if not identical with it.

† MÜLLER, Ueber den Bau d. Echinodermen, *Pl. II. f. 7.*

‡ A. AGASSIZ, Emb. of Echinod. in Mem. Am. Acad., *Fig. 27.*

membrane fully developed with all its plates, cuts, and carrying a prolongation of the ambulacral system as in the adult. It requires but a slight stretch of imagination to reduce our young Cidaris to a Palaechinus. Obliterate the two rows of coronal plates and we have a spherical urchin composed of a series of plates corresponding in every respect to the hypothetical Palaechinus. It consists, namely, only of an abactinal system (the large size of the plates of Cidaris is similar to Palaechinus), of an ambulacral and interambulacral system, composed of hexagonal and pentagonal plates, perfectly flexible, and of an oral opening through which we find teeth projecting. We have thus a complete reconstruction of the typical Palaechinus. Let us now examine in detail the various parts and trace the coincidence still further: the Palaechinidae are Cidaridae where the coronal plates are wanting (those carrying the large tubercles and spines); the test, reduced to the abactinal and actinal systems, being entirely made up of the flexible parts of the buccal membrane of Cidaris, which is capable of great mobility, thus confirming the view taken by Meek and Worthen of the probability of considerable adaptation of shape, without rupture, of parts of the test, as would be the case in Echini when subjected to pressure.

This view has received great support from the discovery of the flexible Echinothuriae, in which the limestone coronal plates are only partly solidified, leaving considerable freedom of motion. The Echinothuria described by Woodward in the Geologist for September, 1863, is undoubtedly the cretaceous representative of the deep-sea Asthenosoma (Calveria, W. Thoms.), of which we owe a short description to Grube. Asthenosoma has also been dredged by Pourtalès and subsequently by Thomson, who has figured it in his Depths of the Sea. I had previously figured a fragment in Part II. of the Revision of the Echini, and have given a full description and figure of the same species in the Hassler Expedition Echini. In all these Echini (Asthenosoma, Echinothuriae, and the Palaechinidae), the whole test is imbricated; the ambulacral and interambulacral plates lap in opposite directions in the Palaechinidae, as they do in the recent species of Echinothuriae. In this family (Echinothuriae) we find the imbricating actinal membrane so closely connected to the coronal plates, that there is no reason why we should not have in Palaechinidae, as we have in Clypeastroids, the actinal membrane reduced to an insignificant member, the coronal plates almost reaching the jaws, or the test composed entirely of plates to be homologized with those of the actinal membrane of Asthenosoma and Cidaris.

The teeth of Archaeocidaris were first figured by Münster (Beit. *Pl. III. f.* 6^d); by Desor (Synopsis, p. 154), in 1856, and attention was called to them by Müller in 1857; he figured the teeth. Hall, on Plate 26 of his Iowa Report, gives figures, showing the existence of jaws in Archaeocidaris Worthenii, though in the text no attention is paid to this. Meek and Worthen have given (in Vol. II. of the Ill. Geol. Rep., p. 227, Fig. 21) a cut (*Fig. 1*), showing the presence of teeth in Melonites multipora, the furrow in the centre of the teeth resembling that of the teeth of Archaeocidaris figured by Müller.

Fig. 1.

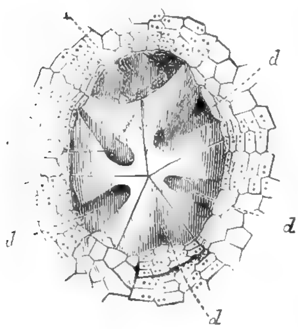


Fig. 5.

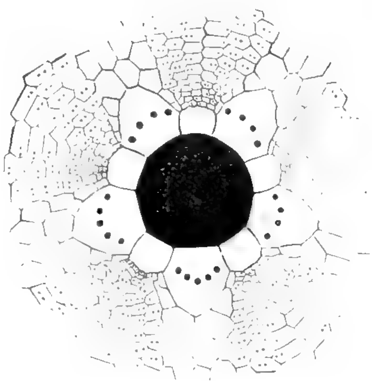
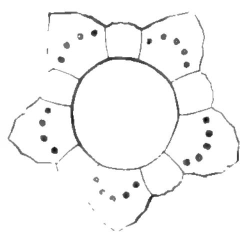


Fig. 6.



The figures given by Meek and Worthen, p. 228, Vol. II., Ill. Geol. Rep. Figs. 21, 22 (*Figs. 5, 6*) are most interesting; they agree entirely with the general structure of the apical disc of Echini, showing ocular and genital plates and a large anal area. The genital openings are more numerous, and there is apparently no madreporic body described, though the presence of an unequal number of pores in the different plates may indicate the presence of such a body; the larger one being probably a madreporic body, as suggested by Meek and Worthen. The presence of two genital openings is not an uncommon feature in recent Cidaridae. I cannot agree with Meek and Worthen in considering the differences in the apical structure as sexual, to judge at least from analogy. In our common Sea-urchins the difference in the sexes can be determined only at the time of spawning by a slightly different coloration, and there is nothing in the shape of the genital plates or in the size and number of the genital pores which indicates a sexual difference.

Fig. 1. Oral opening (somewhat distorted), and jaws of Melonites multipora (natural size), *d d d*, spaces between teeth (foramen of the pyramid ?).*

Fig. 5. Apical disc of Melonites multipora, showing the anal opening, surrounded by the genital and ocular plates, and their connection with the ambulacral and interambulacral pores (two diameters).

Fig. 6. Melonites multipora, having five pores in three genital plates.

* I have to thank Messrs. Worthen and Meek for allowing me to copy their cuts, illustrating a few of the principal points of the genera here mentioned.

How far the two families established by McCoy, which are founded almost entirely upon the nature of the spines and their articulations, are warranted, cannot be ascertained at present; the presence of spines of a uniform structure is an important difference, as compared to spines of two different kinds; but the perforate or imperforate character of the tubercles is not one upon which family characters could be established, unless accompanied by other features.

In Hall's genus Lepidechinus the ambulacra and interambulacra lap in opposite directions. Interambulacra in eight rows; outer pentagonal, others hexagonal. Hall, in his Report on the Geology of Iowa, has given us excellent figures of the tubercles, spines, and portions of the ambulacral and interambulacral plates (*Pl. XXVI*). From all these figures it is apparent that the pores of the ambulacral system are pierced directly through the plates in all the genera.

In Archaeocidaris (*Fig. 2*) there are four plates in the ambulacra; each plate forming vertical rows, much as in Hipponoë and Holopneustes; four

FIG. 2.

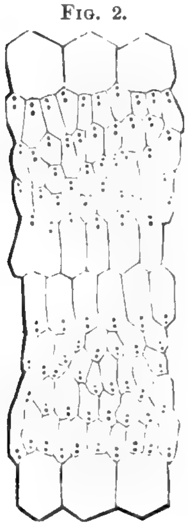


FIG. 7.

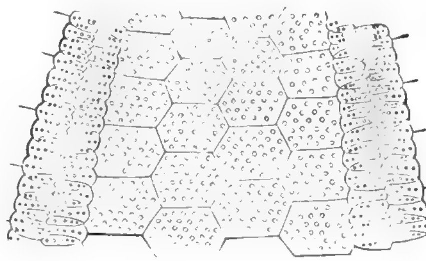
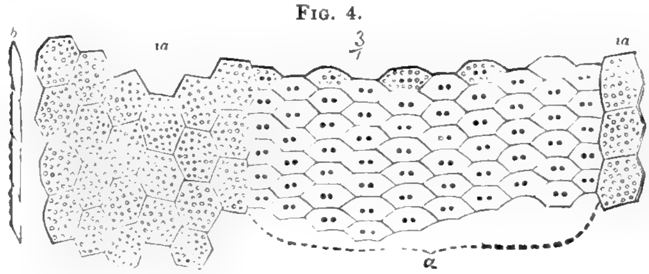


FIG. 4.



rows of hexagonal and pentagonal interambulacral plates, each carrying one large spine and a scrobicular circle.

FIG. 2. Melonites multipora (two diameters). Diagram showing the number and arrangement of the ambulacral pieces and pores, and connection of the former, with the first range of the interambulacral pieces on each side, near the middle of the ambulacral area.

FIG. 7. Palaechinus burlingtoniensis (about two diameters). Diagram showing a part of two ambulacra, and the intervening interambulacral pieces above the middle of the body.

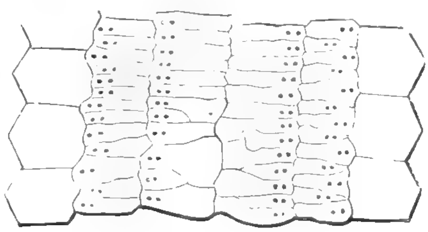
FIG. 4. Lepidesthes Coreyi (diagram enlarged three diameters), showing the number and arrangement

In Palaechinus (*Fig. 7*) we find but two rows of ambulacral plates, with four rows of interambulacral plates, — differences which do not remove so absolutely the Palaechinidae from the Echinothuriae, and show a more intimate relationship between the carboniferous and the cretaceous mailed Echini than has been supposed to exist heretofore.

In Lepidesthes (*Fig. 4*) the ambulacral areas are wider than the interambulacral, and composed of a greater number of rows of plates; while in Melonites (*Fig. 2*) the ambulacral and interambulacral fields, though of different width, are composed of nearly the same number of vertical rows of plates.

These examples of the Perischoechinidae have been taken as the most prominent, and most fitted to show the affinities of this remarkable group of Echini to the regular Echini.

Fig. 3.



It may perhaps not be superfluous to recall that the plates of the poriferous zones of regular Echini (Podophora, Arbacia, some species of Strongylocentrotus, Stomopneustes, etc.) are frequently, in the immediate vicinity of the actinostome, so closely packed together as to pass, from simple zones arching round the tubercles on the abactinal side of the test, to broad, flat surfaces, over which the pores are scattered without any apparent order, forming many rows of ambulacral plates, irregularly packed (*Pl. III^d. f. 5; Pl. I^g. f. 6; Pl. IV^b. f. 1; Pl. V^b. f. 2.*), — the flattened petaloid actinal ambulacra in the regular Echini.

In fact, when we come to analyze more fully the mode of formation of the ambulacral plates we shall find in many genera, — Stomopneustes, Strongylocentrotus, Heterocentrotus, which will be found noticed in the chapter on the water-system, — that in the ambulacral system of the Desmosticha it is possible to have several rows of ambulacral plates on each side of the median line, much as we find them normally developed in the Perischoechinidae; forming, however, in the latter, usually vertical rows of pores, while in the

of the ambulacral pieces (*a*) near the middle of the body, with the two pores penetrating the middle of each piece, and in a few of those above, the granules covering the whole surface of all the pieces. On the left the interambulacral pieces (*i a*) are seen, showing their arrangement, and the comparative narrow breadth of the interambulacral areas. By the side of these plates *b* represents a section of them, illustrating their imbricating arrangement. On the right side of the ambulacral series, only the marginal row of the interambulacral plates is represented.

Fig. 3. Oligoporus Danae (two diameters).

Desmosticha they form more or less regular lateral arcs. We have thus a much less marked difference between the two suborders than would appear on first analysis. We know nothing as yet of the mode of formation of the additional rows of plates either in the ambulacral or interambulacral system; this would throw great light on the homologies of this suborder.

THE SPINES.

As is well known, the tubercles of Echini, from the few large primary interambulacral tubercles of the Cidaridae to the minute tubercles of the abactinal part of the test of the Spatangidae, carry spines which in their general features are identical. Whether we examine the large solid spines of the former or the silk-like spines of the latter, they consist of a shaft and of an articulating head or condyle, forming a ball and socket joint with the tubercle proper (*Pl. XXXV. f. 1, 4, 8, 10; Pl. XXXVI. f. 3, 5, 6, 7, 10, 14; Pl. XXXVII.*); the ligaments which keep the spine in place conceal its base, and are attached to the outside edge of the scrobicular circle and to the milled ring or collar which is at the base of the shaft proper. The notches of the milled ring are the continuation of the striæ or ornamentation of the shaft proper, only the calcareous tissue is more compact, and the dividing lines between the longitudinal striæ are so marked as to be readily distinguished with the naked eye as indentations in the circumference of the flaring collar.

The longitudinal and transverse sections of the principal families given on *Pls. XXXV. - XXXVII.*, show the more important features distinguishing them. We find, as far as the structure is concerned, greater differences between the Cidaridae and the other Desmosticha than we find between the Clypeastroids and Spatangoids on one side and the remaining Desmosticha on the other. Yet, to judge from the external appearance of the small silk-like spines of the Petalosticha and Clypeastroids when compared with the comparatively huge spines of the Desmosticha, we might have expected marked structural differences.

In the Cidaridae the whole of the shaft is made up of small limestone meshes, radiating from a central part, consisting of somewhat larger cells. These cells are simply arranged in spokes, and do not greatly increase in size towards the periphery (*Pl. XXXV. f. 2-5*). The exterior of the shaft is made up of larger elliptical limestone wedges, shooting out irregularly from the periphery of the homogeneous interior, and connected by irregular cross-bars, which form the spines, serrations, granular and other ornamentation of the spines of Cidaridae. As fast as the outside sheath increases in breadth, by sending out shoots from the outer edge, and by the increase in number

and breadth of the smaller wedges intercalated between the older ones, as the spine increases in the periphery, the outer edge of the homogeneous centre is increased by the addition of smaller cells like those of the central part of the shaft. The shape and mode of connection of the wedges of the outer sheath are frequently quite characteristic of the different genera and species (*Pl. XXXV. f. 1–5*). The structure of the papillæ is more homogeneous; they have no regular outer sheath of wedges, as in the primary interambulacral spines. They resemble closely in their structure the spines of Arbaciadae.

As the spines of Cidaridae are among the most common fossil remains in some of the formations, I have given detailed figures of the spines of several of the genera, to show the variations which may occur in the same species, either in size or in shape, according to their position on the test. These changes are limited to the interambulacral spines. The ambulacral papillæ, though differing so strikingly from the interambulacral primary spines, yet are not variable, and show no differences of consequence in the course of the ambulacral areas. The papillæ which surround the base of the primary interambulacral spines are similar in structure to the ambulacral papillæ, there being no other primary spines in the ambulacral system of the Cidaridae. I need not go beyond referring to the explanation of the plates (*Pl. I^c., I^e.*), to show how impossible it is to base specific distinctions upon the structure of the spines, even when they come from the same part of the test. Compare, for instance, the figures of the abactinal spines of Phyllacanthus gigantea (*Pl. I^e. f. 27–29*). The great differences observed in the spines of Phyllacanthus baculosa are specially noteworthy (*Pl. I^c f. 34–38; Pl. I^e. f. 11–20^a*). In all Cidaridae we find certain primary spines frequently quite smooth, slender, pointed, in the midst of the other spines (*Pl. I^e. f. 17, 38; Pl. I^c. f. 22, 35*). Compare especially the different spines of Phyllacanthus dubia (*Pl. I^e. f. 7–10*) and of Phyllacanthus imperialis (*Pl. I^f. f. 2*). In several of the genera the tips of the primary spines are often cup-shaped, and this, added to the other structural differences, often produces a very marked contrast in specimens of the same species in which one or the other type of spine may predominate. Compare the spines of Goniocidaris tubaria (*Pl. I^c. f. 9–14; Pl. I^e. f. 32–36*), and of Goniocidaris geranioides (*Pl. I^c f. 15–17*).

The spines of the actinal surface are usually flattened, elongate, in Goniocidaris canaliculata, and in Phyllacanthus (*Pl. I^c., Pl. I^e.*); in Porocidaris they assume a very peculiar shape (*Pl. I^e. f. 40^a, 41*); in Dorocidaris they are

serrate and flattened (*Pl. I^c. f. 32, 33*). As a general thing the actinal interambulacral spines of the Cidaridae are small compared to those of the abactinal primary interambulacral tubercles. In the ornamentation of the spines we find extraordinary differences, all possible passages between the perfectly smooth pointed spines to spiny or lamellar and cup-shaped ornamentation or nodes. Compare this passage in the spines of Phyllacanthus baculosa, which pass gradually from the extreme of *Pl. I^c. f. 35* to that of *Pl. I^c. f. 36^a*, or in the spines of Phyllacanthus verticillata passing from *Pl. I^c. f. 42* to *Pl. I^c. f. 40^a*, and in the gradual transition of the smooth spines of Goniocidaris to the cupped spine so characteristic of the genus. The greatest differences to be noticed are perhaps found in the spines of the huge Phyllacanthus gigantea, where we find at the same time the lamellar and spiny structure so frequently found in the fossil spines of many species of Rhabdocidaris.

The microscopic structure of a section of a primary interambulacral spine shows the cause of this great variety, which is due to the independent growth of the outer sheath; while in other regular Echini the growth of the outer layer takes place uniformly with the increase in size of the spine.

In the Perischoechinidae the centre of the shaft is hollow; the body of the shaft is made up of very close minute cells, with an outer independent sheath of solid lamellar wedges, as in the Cidaridae proper.*

In the fossil genus Hemicidaris the structure of the spines, as shown by a section, is identical with that of the recent Cidaridae of the type of Cidaris metularia; the position of this genus among the Cidaridae has been considered as doubtful by Wright; he has established for it a separate family.

The other Echini in which the shaft of the spine has a homogeneous cellular structure are the Arbaciadae and the Salenidae. In the Salenidae (*Pl. XXXV. f. 16*) the radiating lines of cells are quite marked, and we have the same independent outer sheath as in the Cidaridae proper. In the Arbaciadae the structure of the inner part of the shaft is like that of the Cidaridae, only the cells are comparatively larger (*Pl. XXXV. f. 7, 9*), and the marginal wedges are large, elliptical, and disconnected, similar to the ordinary wedges of the Echinidae proper, only developing so as to form a deeply indented edge (*Pl. XXXV. f. 7, 9*) in a transverse section. The homogeneous central part of the shaft is well seen in the longitudinal sections of the Cidaridae (*Pl. XXXV. f. 1, 4*) and of Arbacia (*Pl. XXXV.*

* Müller has given figures of spines of Lepidocentrus in his Neue Echinodermen d. Eifel, 1857.

f. 8). In the fossil genus Acrosalenia (*Pl. XXXV. f. 6*) we find the nearest approach in the structure of the shaft to Arbacia, only without the characteristic edge. It recalls also the structure of the recent Phymosoma (*Pl. XXXVI. f. 11*), but has not, like it, the well-marked circular rings, denoting the different stages of growth of the spines, which is a structural feature characteristic of all the other Echini — whether Desmosticha, Clypeastroids, or Petalosticha (with the exceptions just enumerated) — which I have had occasion to examine, and the sections made extend to the principal genera of these suborders. In the Diadematidae we have a combination of two modes of growth, of the concentric and of the cellular. Near the base of the spine, which may be hollow (*Pl. XXXV. f. 10*) in the primary interambulacral ones, or solid (*Pl. XXXV. f. 15*) in the small ambulacral spines, the section is made up of a couple of rings; the inner ring consists of spokes of small cells, irregularly arranged between the large outer solid wedges; this is then succeeded by a second ring of irregularly arranged cells, edged by a row of small solid wedges (*Pl. XXXV. f. 12*); higher upon the shaft of the spine the solid wedges have become connected, and are separated by the spokes of minute cells (*Pl. XXXV. f. 11*). The wedges form the verticillations so characteristic of the Diadematidae, and, in fact, they constitute the ornamentation of all the spines, whether they form an independent sheath, as in the Cidaridae, growing in size at the same time and independently with the central part of the shaft, or, as in the other Echini, form a part of the inner substance of the shaft, and increase at the same time with the cellular interlamellar substance.

In the Echinometradae we find the concentric rings most distinctly marked. Each ring terminates by a row of larger cells, indicating clearly the growth to have taken place at definite intervals, until the spines have reached a maximum size; but even then, as has been well shown by Carpenter, they do not cease to grow, as huge broken spines of Heterocentrotus are very soon repaired, and attain frequently a larger size than they would under ordinary circumstances.

The great size of the wedges and their intermittent growth are especially marked in sections of Echinometra (*Pl. XXXVI. f. 1*), of Stomopneustes (*Pl. XXXVI. f. 2*), and of several species of Strongylocentrotus (*Pl. XXXVI. f. 4, 9*). In Heterocentrotus (*Pl. XXXVI. f. 8*) and Podophora the wedges are small, connected; hence the smooth or finely granular surface presented by the outer surface of all the spines of these genera. The Echinidae proper

are remarkable for the great size and small number of the outer wedges of the surface of the spines, and the narrow interlamellar cellular tissue, as, for instance, in Echinus melo; the spines of this family differ from those of the Echinometradae proper by the small amount of interlamellar tissue, and the smaller number of outer wedges. In some genera, as Mespilia and Trigonocidaris, this feature is particularly striking; yet in the genera Phymosoma (*Pl. XXXVI. f. 11*) and Hemipedina (*Pl. XXXVI. f. 12*) the outer wedges are minute, and the interlamellar space, owing to the indistinctness of the concentric rows, recalls the structure of the interior of the shaft of the Arbaciadae. In the genus Trigonocidaris the section of a primary interambulacral spine (*Pl. XXXVI. f. 13*) closely resembles that of the Diadematidae in its structure; in fact, the spines of Echinidae are like solid spines of Diadematidae, with more marked concentric rings of growth.

The spines of the Echinonidae (*Pl. XIV. f. 2*) resemble more those of the Desmosticha than those of the Petalosticha; the same is also the case with the spines of the abactinal region of Echinolampas (*Pl. XVI. f. 13, 16*). The spines of Rhynchopygus (*Pl. XXXVII. f. 12*) do not differ from those of the other Petalosticha. In the Clypeastridae and Petalosticha the spines are remarkable for the proportionally great size of the collar and the prominence of the milled ring (*Pl. XXXVII. f. 3, 16, 18, 20*); also for the peculiar articulation of the condyle, which is not smooth as in the other Echini, but consists of four or more knobs fitting into the crenulations of the mammary boss (*Pl. XXXVII. f. 3, 4, 9, 11*). Owing to the great size of the collar compared to the length of the spines, they are capable of rapid movements. This is readily observed in living specimens of Echinarachnius, Mellita, Rhynchopygus, Moira, Brissus, Meoma, showing probably that these spines are far more sensitive than the spines of the Desmosticha, and may in these instances be even coarse organs of touch. The spines of the actinal and abactinal sides of the Clypeastroids are usually different; they are clavate and short on the abactinal side (see Mellita, *Pl. XXXVII. f. 1*); while they are curved, pointed, and slender on the actinal side (*Pl. XXXVII. f. 2*). The same is the case in Echinodiscus (*Pl. XXXVII. f. 4*). In the Laganidae (*Pl. XXXVII. f. 3*) and Echinanthidae (*Pl. XXXVII. f. 9*), there appears to be no difference in the spines of the two surfaces.

In the Petalosticha the spines of the abactinal surface are curved above the milled ring (*Pl. XXXVII. f. 14, 16, 19*), and pointed, gradually tapering towards the tip; while the spines of the actinal surface, more especially those

of the actinal plastron, are spoon-shaped at the tip (*Pl. XXXVII. f. 18*). In the Clypeastridae the spines are frequently serrated (*Pl. XXXVII. f. 1, 4*) much as the spines of the Desmosticha. The spines of the Petalosticha are generally smooth (*Pl. XXXVII. f. 18, 20*). In some of the longer curved spines of the abactinal surface prominent distant serrations are developed, as in Maretia (*Pl. XXXVII. f. 14*) and Lovenia (*Pl. XXXVII. f. 17*).

In transverse sections of the spines of Scutellidae the interior is hollow, with large well-separated marginal wedges, and but little cellular interlamellar substance (*Pl. XXXVII. f. 5, 6, 8*), rendering the spines of the Scutellidae quite transparent. The spines of Echinanthidae (*Pl. XXXVII. f. 9, 10*) resemble quite closely those of the Spatangina (*Pl. XXXVII. f. 13, 15*), in which we have a large hollow central space, with two or three concentric rings of cellular substance intercalated as narrow strips between the solid marginal wedges. The structure of the spines of the Scutellidae is quite similar to that of the Arbaciadae, if the latter had a hollow central shaft.

FASCIOLES.

Among the Spatangoids there are several families where the spines are specialized along certain lines (the so-called fascioles or semitæ) in which they always retain embryonic features, being either articulated (*Fig. 8*) or directly attached to the test, and provided at the extremity and along the shaft with a more or less sensitive vibratile membrane, as all young spines originally are. These fascioles are very varied in their course; they extend round the petals, in which case they are called peripetalous, as in Brissopsis (*Pl. XIX. f. 7–9; Pl. XXI. f. 2*), Brissus (*Pl. XXI*^{a}. *f. 1*), Metalia (*Pl. XXI. f. 5; Pl. XXI*^{a}. *f. 4; Pl. XXI*^{c}. *f. 8*), Rhynobrissus (*Pl. XXIII*^{a}. *f. 6*), Meoma (*Pl. XXII. f. 3*). The subanal plastron, as it is called, is edged by a fasciole which encloses within its area a part of the inner poriferous zone of the actinal posterior lateral ambulacra: this is called the subanal fasciole, as in the case of Brissopsis, of Maretia (*Pl. XIX*^{b}. *f. 8*), of Lovenia (*Pl. XIX*^{c}. *f. 2*), of Spatangus (*Pl. XIX*^{c}. *f. 6*), of Metalia (*Pl. XXI*^{a}. *f. 5*), and of Rhynobrissus (*Pl. XXIII*^{a}. *f. 4*). In other genera there is connected with the peripetalous fasciole a band running towards the posterior extremity, bending downwards, and passing under the anal system; this is called the lateral fasciole. It occurs, among other genera, in Agassizia (*Pl. XIX*^{a}. *f. 1, 2*), in Linthia (*Pl. XIX*^{a}. *f. 7, 8; Pl. XXI*^{b}. *f. 5, 7*), in Tripylus (*Pl. XXI*^{c}. *f. 4*), in Schizaster (*Pl. XXIII*^{a}. *f. 1, 3*), in Moira (*Pl. XXIII. f. 5, 6*). The lateral fasciole is sometimes disconnected from the peripetalous fasciole, the portion which passes under the anal system alone remaining; or when there is no distinct subanal plastron formed, the subanal fasciole remains open: the first case occurs in Faorina, the latter in Meoma (*Pl. XXIII. f. 4*) and in Linthia. It is then called the anal fasciole. An anal fasciole is also sent off as a branch of the subanal plastron (Brissopsis), and may or may not enclose the anal system. The subanal fasciole of Rhynobrissus is subdivided into two areas by a transverse fasciole. The anterior part of the peripetalous fasciole of Faorina (*Pl. XIX*^{a}. *f. 4*) is double, and encloses a secondary area.

FIG. 8

In Echinocardium (*Pl. XX. f. 1, 5*), Breynia (*Pl. XV*^{a}. *f. 7*), and Lovenia (*Pl. XIX*^{c}. *f. 1*) we find a still different kind of fasciole, — an internal fasci-

ole enclosed within the anterior lateral petals, extending across the abactinal extremity of the posterior poriferous zone of the posterior lateral ambulacra, and running parallel to the odd ambulacrum, crossing it at some distance above the ambitus. This internal fasciole takes the place of the peripetalous fasciole, but in Breynia both occur together. The use of these bands of embryonic spines is evidently to keep the petals free from foreign matters. We always find along the fascioles large accumulations of dirt, which are held there by the minute spines as by a sieve. Troschel first called attention to the true nature of the appendages of the fascioles; Müller subsequently, in his Embryology of the Echinoderms, gave excellent figures of the spines of the fascioles of Schizaster; yet, in spite of these observations, dating back to 1852, recent writers persist in stating that the fascioles carry true pedicellariae, while in all Spatangoids pedicellariae are found scattered over the whole test, but they are especially numerous round the actinostome and along the bare ambulacral actinal avenues.

Lütken has attempted, from the arrangement and combination of the fascioles, — their presence or absence, — to make a classification of the Spatangoids. As he himself says, it is a most artificial one, and one which can only be used as an auxiliary with other features; the subanal, anal, and lateral fascioles are subject to great changes during growth, and to considerable variations in older specimens. The peripetalous and the internal fascioles offer more constant characters.

PEDICELLARIÆ.

O. F. MÜLLER, in his "Zoologia Danica," was the first to point out the existence of certain organs in sea-urchins which have long remained a puzzle to naturalists. To these organs he gave the generic name Pedicellaria, and considered them as parasites of the sea-urchins. Of his genus, Pedicellaria, he describes three species, which are now known to be either different stages of development or different kinds of pedicellariæ, situated in various parts of the shell of the sea-urchin. Our knowledge of the pedicellariæ has been materially changed by the views of Delle-Chiaje, who in 1825 figured and described the pedicellariæ of several sea-urchins and starfishes. He, however, no longer considers them simple parasites, but says distinctly that they form a part of the test of the Echinoderms, and help them in seizing their prey and taking hold of adjoining bodies. Much of this view has been corroborated, and, like many of the shrewd observations of Delle-Chiaje, is gaining only now the recognition it should have received long ago. Valentin, in 1841, gives in his "Anatomy of Echinus" excellent figures and descriptions of pedicellariæ which he considers as organs of prehension. Agassiz at that time suggested the possibility of their being young stages of Echini in consequence of the discoveries just made by Sars of the remarkable development of a species of starfish. This, it is needless to say, is a view he has long ago abandoned, though he is most persistently credited with it even at the present time. Subsequently, Erdl, Duvernoy, Müller and Troschel, Sars, Stimpson, Norman, and Stewart, have figured and described a number of pedicellariæ of Echini and starfishes, and have made a more or less successful attempt to use their characters as aids in distinguishing closely allied species.

In an article on pedicellariæ in the "Annales des Sciences Naturelles" for 1869, Perrier gives a large number of excellent figures of the pedicellariæ of starfishes and sea-urchins; unfortunately the writer passes over much of what has been done on the very appendages he was describing, so that he leaves the question of their nature as it stood in the days of Valentin, in spite of the many observations made, and hints of their true nature thrown

out, by Müller, Troschel, Sars, and A. Agassiz, which should have prevented much useless speculation.* No attempt has been made to ascertain the homologies of these organs, with the exception of a short article in the American Naturalist, intended to give the results which have been reached by the writer since 1864, from the study of the embryology of starfishes and Echini.

Pedicellariæ are, as is well known, scattered in between the spines over the whole surface of the shell. The pedicellariæ consist of a calcareous stem

* The attempt Perrier makes of applying our knowledge of the pedicellariæ to the classification of the collections of the Jardin des Plantes must be regarded as somewhat unsatisfactory. The observations are made on museum specimens, and though the material accumulated is very considerable, yet no additional information is given on the nature of the pedicellariæ. The omissions from the literature of Echinoderms are such that no critical revision of the subject from a new point of view could be made, as he attempts. In the catalogue of the species no notice has been taken of numerous species of starfishes and sea-urchins described by Sars, Lütken, Stimpson, Grube, Mobius, Verrill, and A. Agassiz, and the anatomical works relating to the subject are incompletely quoted. The greater part of what has appeared on pedicellariæ and spiculæ by Johannes Müller, Stewart, Troschel, Stimpson, A. Agassiz, and Herepath has passed unnoticed, and the conclusions which present the *résumé* of the work, given by the author as his own, are simply confirmations and additional details of the work of his predecessors.

As the starfishes are not particularly to be discussed, I will give only a few examples of the manner in which the work has been done, leaving further details to the discussion of the Echini, here more properly in question. Simple inspection does not enable us to distinguish at once by the pedicellariæ, as stated by Perrier, whether a starfish belongs to the group with four or only two rows of suckers. Stimpson has given excellent descriptions of starfishes, in which he has made use of the characters derived from pedicellariæ several years before the present attempt of Perrier. These two statements will show that there remains as original with Perrier, as far as the starfishes are concerned, all the work of detail for many species. We are told that Stichaster has been established by Norman. Heliaster helianthus is placed in Asteracanthion. Astropecten Mulleri is credited to Valenciennes. Common West Indian and North American species, well described by Lütken and Stimpson, receive new names. Well-known species from Chili and the Arctic regions share the same fate. Solaster is said to have no pedicellariæ. In fact, both for starfishes and sea-urchins the museum MS. names attached to specimens are invariably taken as correct; no critical examination of the species can possibly have been made, and the whole value of the method urged by Perrier becomes questionable. We do not know from his observations how far the pedicellariæ vary in any one species of starfish or sea-urchin. That they do vary considerably is well known; he has admitted nominal species as well defined, from their pedicellariæ, which show in several cases differences due either to size and age or to extensive geographical range. No reliable data for systematic zoölogy can be drawn from the very laborious researches of Perrier, owing to this lack of criticism, and we must fall back to the older memoirs for trustworthy information. All that bears on the development of pedicellariæ written by Erdl, Sars, Koren and Danielssen, Johannes Müller, and myself has been ignored.

The generalizations regarding the nature of the pedicellariæ in the regular and irregular Echini (as understood by Perrier) are not correct. He corrects Valentin for several errors long ago pointed out by Müller and Stewart, brings up as new facts (see Valentin 1841, Stewart 1865) the presence of spiculæ in ambulacral tubes. He characterizes as new families the Cidaridae, Diademidae, Echinocidaridae, apparently ignorant that Müller, Peters, and Gray have done excellent work on this very subject. A genus

(*Pl. III. f. 6; Pl. IV. f. 5, 15; Pl. X. f. 7, 11–14; Pl. XI^f. f. 6; Pl. XXVI. f. 3, 4, 16*), articulating at its base upon a small granule of the test; this is surrounded by a muscular sheath expanding into a somewhat swollen portion, with a thimble-shaped knob at the end. This knob, though it seems solid and compact at first sight, is in reality split into two or three wedges (*Pl. X. f. 15; Pl. XXVI. f. 37; Pl. XXV. f. 26; Pl. XXVI. f. 15, 18; Pl. XXV. f. 39*), which can be opened and shut at will. When open, these pedicellariæ may be compared to a three-pronged fork, except that the prongs

well established by Peters in 1853, which is well known to every writer on Echini Echinothrix), is nowhere alluded to, except under the name of Savignya, given to it some time after by Desor. In those species where the pedicellariæ are most abundant and seem to play an important part (Temnopleurus, Salmacis, etc.), the whole subject is passed over in a few words; no mention even is made of Grube's suggestions as to the pedicellariæ of these interesting genera. It cannot be from want of material, for there is ample material of alcoholic species of Temnopleurus. The following blunders have crept into his Systematic Catalogue. We find, on page 146, Echinus subangulosus *Bl.*, E. longispinus *Ag.*, E. lezaroides *Ag.*; this we presume from an examination of the specimens. A little further on the *same species* appear in a new genus, as Psammechinus subangulosus *Ag.*, P. longispinus *Bl.*, P. laganoides; this time entered in his catalogue from the Catalogue Raisonné of Agassiz. *Lezaroides* is a calligraphic error in the label of P. laganoides. The Museum of Paris is said to possess only one species of Astropyga; there is a fine series of A. pulvinata. No species of Echinus is examined (for want of specimens), yet the best possible series of Echinus acutus exists in the Museum. The genus Sphaerechinus is completely misrepresented, being made to include the typical Echinus esculentus *Lin.* and Toxopneustes gibbosus, while Sphaerechinus brevispinosus of Desor, the type of Sphaerechinus, is placed in Toxopneustes. Loxechinus purpuratus (from Mendocino, California) appears as Echinometra No. 274, Echinometra lucunter is ascribed to Gray, and in the same genus we find Echinometra (Podophora) Quoyi *Bl.*, which does not appear in Podophora at all. All the MS. species of Acrocladiae of Blainville and Valenciennes are taken as valid.

In the irregular Echini the following errors occur. Michelinia elegans *Mich.* is said not to exist in the Museum collection; there is a large series of this species under the name Laganum Lesueuri. Encope grandis is omitted. Echinodiscus digitatus and Rotula augusti, the same species, appear in two different genera. No mention is made of Clypeaster subdepressus (Clypeaster prostratus *Rav.*). We have two new species of Brissopsis from the Baltic. Lovenia is spelled Loevenia. Meoma nigra *Gray* is placed in the genus Breynia Echinocardium cordatum and Echinocardium ovatum appear (from the Baltic) as new species of Amphidetus, No. 171 and No. 193. We find Amphidetus Novae Zelandiae of *Val.*, nothing apparently being known of Gray's species from the same locality. Moera atropos exists in the Museum collections. Lovenia quadrimaculata *Val.* must have been placed in the genus Lovenia without any examination; it is only a Maretia planulata.

I have been perhaps too particular in pointing out the systematic errors of this paper, but as the details are remarkably accurate, and the drawings are admirably done, it was important that the value of the generalizations should be known, and the nature of the specific determinations be clearly recognized, before making use of this material, which is most important as an immense accumulation of new facts, and can be usefully applied as far as genera are concerned, but upon which no reliance can be placed as far as the specific distinctions claimed for it in the memoir of Perrier are concerned, unless the above discrepancies are taken into account.

are arranged concentrically instead of on one plane, and when closed they fit into one another as neatly as the pieces of a puzzle. *Pl. X. f. 15; Pl. XIV. f. 9* represent end views of some of these pedicellariæ.

If we watch a sea-urchin after he has been feeding, we shall learn at least one of the offices which this singular organ performs in the general economy of the animal. That part of the food which he ejects passes out of the anus, an opening on the summit of the body in the small area where the zones of which the shell is composed converge. The rejected particles, thrown out in the shape of pellets, are received on these little forks, which close upon them like forceps, and they are passed from one to the other, down the side of the body, till they are dropped off into the water. Nothing is more curious and entertaining than to watch the neatness and accuracy with which this process is performed. One may see the rejected bits of food passing rapidly along the lines upon which these pedicellariæ occur in greatest numbers, as if they were so many little roads for the conveying away of the refuse matter; nor do the forks cease from their labor till the surface of the animal is completely clean and free from any foreign substance. Were it not for the pedicellariæ the food thus rejected would become entangled among the tentacles and spines, and remain stranded there till the motion of the water washed it away. These curious little organs have other offices besides this very laudable and useful one of scavenger. They occur over the whole body, while they pass the excrements only along certain given lines. They are specially numerous about the mouth, where they are much shorter (*Pl. X. f. 9, 10*) and more compact; the muscular sheath below the head is quite short, the tripartite head resting directly upon the limestone rod of the base.

On watching the movements of the pedicellariæ we find that they are extremely active, opening and shutting their forks unceasingly, reaching forward in every possible direction, the flexibility of the sheath enabling them to sweep in all the corners and recesses between the spines, and occasionally they are rewarded by catching hold of some unfortunate little crustacean, worm, or mollusk which has become entangled among the spines. They do not seem to pass their prey to the mouth (at least I have never succeeded in seeing sea-urchins pass the food thus caught), but merely throw it off from the surface like any other refuse matter. Their mode of eating, also, — a sort of browsing, by means of their sharp teeth along the surface of the rocks, — does not favor the idea of using the pedicellariæ as forks.

In the Cidaridae the pedicellariæ are placed at the base of the circle of the papillae surrounding the primary interambulacral spines; they are more numerous near the ambulacral areas. They are characterized by a shaft made up of longitudinal rods, into the tip of which is set a second short calcareous rod, somewhat smaller in diameter than the shaft of the base (*Pl. XXIV. f. 5, 7*). The longitudinal rods are soldered together by short irregular transverse processes. There are but few pedicellariæ on the buccal membrane, and frequently they are entirely wanting, while in the other regular Echini the abactinal membrane is, at certain points, studded with short-stemmed pedicellariæ. The head of the pedicellariæ of the interambulacral pedicellariæ are elongate (*Pl. XXIV. f. 7, 11*), toothed along the edges, when they have reached their full size (*Pl. XXIV. f. 2, 3, 3^a, 4*), while in the smaller stages the margins are nearly smooth (*Pl. XXIV. f. 1*). The young of these pedicellariæ are quite solid and compact (*Pl. XXIV. f. 9*).

There are found on the abactinal system of Dorocidaris and other genera short-stemmed, stout-headed pedicellariæ, much more delicate than those just described (*Pl. XXIV. f. 5, 6*). The separate prongs of these short pedicellariæ are rectangular, with a pointed tip, a large open space at the base of the prong, and the same transverse bar dividing the top into a distinct terminal triangular cavity (*Pl. XXIV. f. 6*), as in the long-headed pedicellariæ (*Pl. XXIV. f. 9*). Below this bar there is an elongate cavity with serrated edges; the very tip of the prong terminates in a hook (*Pl. XXIV. f. 8*).

In Goniocidaris, we find seated in the pits of the sutures of the interambulacral and ambulacral median lines, a large, stout-headed, short-stemmed pedicellaria (*Pl. XXIV. f. 12, 13*), similar to those so numerous in the abactinal system of other genera.

In Porocidaris the long-headed pedicellariæ are remarkable for the opening near the base (*Pl. XXIV. f. 11*). In the Diadematidae the large tridactyle pedicellariæ resemble somewhat those of the Echinidae proper; they differ in having few large marginal serrations (*Pl. XXIV. f. 14, 37, 40*); the extremity of the prong is frequently spoon-shaped and widest at its very tip, as in Asthenosoma. In the group of Echinothuriae occurs the only case of pedicellariæ with four prongs. Thomson has figured such pedicellariæ in his "Depths of the Sea" as found in Phormosoma. In Echinothrix the similarity of the large, long-headed pedicellariæ (*Pl. XXIV. f. 33 – 36*) to those of Echinidae proper is very marked; they differ, however, in the proportions

of the base and of the spathiform prolongation; the latter is in Echinothrix wider than the base, the opposite is the case in Echinidae proper. The limestone rod of the shaft is slender, with a large terminal head; the soft parts surrounding the head and shaft are greatly developed. I have figured the small broad-headed pedicellariæ of Asthenosoma in the Hassler Echini. The buccal pedicellariæ of the Diadematidae differ from those of the Echinidae in having a solid base (*Pl. XXIV. f. 37'*).

The pedicellariæ of the Arbaciadae are of two kinds. Those near the actinostome have a short muscular shaft seated upon a long base, strengthened internally by a slender rod ending in a broad head. The muscular base supports a stout head (*Pl. XXVI. f. 4, 5*), with strong sharp teeth near the tip. The other kind differs only in the length of the upper muscular sheath and the solid, nearly bare calcareous shaft supporting it. In the abactinal part of the test the long-stemmed pedicellariæ (*Pl. XXVI. f. 3*) are especially abundant in the interambulacral spaces close to the ambulacral areas. The muscular sheath is so long that in alcoholic specimens the weight of the head is sufficient to bend it over; when living, these pedicellariæ are most active, reaching out in all possible directions. In Podocidaris the pedicellariæ occur over the whole abactinal surface (*Pl. IV. f. 8*), the head is still larger in proportion to the length of the shaft, than in Arbacia, and, as has been mentioned already, they are supported upon small tubercles with distinct scrobicular circles.

In the Echinometradae, as limited here, the pedicellariæ do not differ very essentially from those of the Echinidae proper, and we can apply to them the terms introduced by Valentin to denote, according to their position and shape, the different kinds of pedicellariæ. The buccal or ophicephalous pedicellariæ are short-stemmed, stout-headed, the base ending in more or less complicated and regular semicircular arcs (*Pl. XXVI. f. 8*). They are figured with their soft parts in S. Dröbachiensis, in *Pl. X. f. 9, 10*, and the calcareous prongs in *Pl. XXIV. f. 17, 19, 21*; other ophicephalous pedicellariæ of Strongylocentrotus are figured in *Pl. XXIV. f. 27*, and of Stomopneustes in *Pl. XXIV. f. 32*. The gemmiform pedicellariæ are remarkable for the great development of the soft parts, and the slender prongs of the heads, usually terminating in two large hooks, placed one above the other in Echinometradae (*Pl. XXIV. f. 18, 24; Pl. XXVI. f. 10, 14*), while they are nearly on the same level in Echinidae proper. The third kind are the long-headed tridactyle pedicellariæ, in which the calcareous parts take the greatest

development (*Pl. X. f. 7, 11, 12*); the prongs have a triangular base and a more or less spoon-shaped tip, slightly serrated, as in Strongylocentrotus Dröbachiensis (*Pl. XXIV. f. 15, 16, 22, 23*), S. lividus (*Pl. XXIV. f. 25*), S. nudus (*Pl. XXIV. f. 26, 28*), Stomopneustes variolaris, (*Pl. XXIV. f. 31*), and in Echinometra (*Pl. XXVI. f. 9, 11, 12, 13*). In Heterocentrotus (*Pl. XXVI. f. 1, 2*) the tridactyle pedicellariæ are of the type called trifoliate; in Echinometra (*Pl. XXVI. f. 11*) there is no doubt these trifoliate pedicellariæ are only the younger stages of the tridactyle forms.

The principal differences between the pedicellariæ of the Echinidae proper and the Echinometradae consist in the position of the hooks of the gemmiform pedicellariæ, which invariably terminate on one level, both in the Triplechinidae (*Pl. XXV. f. 4, 16, 17, 20*) and in the Temnopleuridae (*Pl. XXV. f. 2*). The differences in the ophicephalous pedicellariæ of the two families are not very marked; compare (*Pl. XXV. f. 1, 14, 19, 21*) the pedicellariæ of Temnopleurus, of Echinus, and of Toxopneustes with those of Echinometra and of Strongylocentrotus referred to above. The same is the case with the tridactyle pedicellariæ of the Temnopleuridae (*Pl. XXV. f. 1, 2*) and of the Triplechinidae (*Pl. XXV. f. 3, 5, 6, 11, 18*); they agree most closely with the corresponding pedicellariæ of the Echinometradae, — the principal distinction consists in the more slender, spoon-shaped prong.

In the Clypeastridae we find great differences in the pedicellariæ; in some cases they approximate closely to the tridactyle pedicellariæ of the Echinidae and Echinometradae, — see one of the prongs of a tridactyle pedicellaria of Clypeaster subdepressus (*Pl. XXV. f. 24, 25', 42*), or the more elongate type of the same species (*Pl. XXV. f. 22*), — while what must be considered the ophicephalous pedicellariæ of Echinanthus take most extraordinary shapes (*Pl. XI^f. f. 6–9*). Another form of pedicellariæ is the hemispherical kind, supported upon a long, slender, flexible, muscular shaft attached to a base, strengthened by a comparatively stout rod (*Pl. XI^f. f. 10, 11*).

In Echinarachnius the pedicellariæ have but two prongs, as in the hemispherical pedicellariæ of Echinanthus. They are supported upon a short, stout, calcareous rod, at the base of a long, powerful, muscular band, supporting a comparatively small bifid head. *Pl. XXVI. f. 15, 16; Pl. XXV. f. 38, 39*, represent them in different attitudes. *Pl. XXVI. f. 17, 18; Pl. XXV. f. 40, 41*, are various stages of growth, although I have not had occasion to examine the pedicellariæ of a large number of Clypeastroids, yet the great variety of the forms observed is very remarkable.

In the Petalosticha the genera which have been examined show a much greater uniformity of plan. The pedicellariæ of the Echinonidae resemble the short type of tridactyle pedicellariæ of Clypeaster, with a somewhat longer, flexible, muscular shaft (*Pl. XV. f. 2*). In the Cassidulidae the only pedicellariæ observed are figured on *Pl. XVI. f. 15*; they resemble the small, tridactyle, short-stemmed pedicellariæ of Spatangus. Very remarkable pedicellariæ have been described in Pourtalesia; they are figured on (*Pl. XVIII. f. 16–18*).

In the genera Echinocardium (*Pls. XXV., XXVI.*) Lovenia, Leskia, Breynia, Spatangus, Maretia, Brissus, Schizaster, and Metalia, of which I have examined pedicellariæ, we find a remarkable uniformity of type, and very slight differences among the different families. We can reduce them to two types, in one of which the heads consist of more or less slender prongs, leaving wide open spaces (*Pl. XXVI. f. 37*), resembling the gemmiform type of the Echinidae and Echinometradae, but of which the tips are merely serrated, and never carry large terminal hooks; this type is the most common among the Spatangoids, and is found in Echinocardium (*Pl. XXVI. f. 19; Pl. XXV. f. 30*), Lovenia (*Pl. XXV. f. 31; Pl. XXVI. f. 36*), Breynia (*Pl. XXV. f. 32*), Maretia (*Pl. XXV. f. 33, 34; Pl. XXVI. f. 21, 22*), Meoma (*Pl. XXVI. f. 28, 29, 33, 34*), Brissus (*Pl. XXVI. f. 38*), and in Schizaster (*Pl. XXVI. f. 41, 42*). The other includes what we may call the ordinary tridactyle type, with a stout head, broad base, and short stem, such as we find in Spatangus (*Pl. XXVI. f. 23, 25; Pl. XXV. f. 35*), and the long-headed, small-based, long-stemmed, tridactyle pedicellaria, with smooth or serrate edges, occurring in Echinocardium (*Pl. XXV. f. 26, 27*), in Spatangus (*Pl. XXVI. f. 26, 27*), in Meoma (*Pl. XXVI. f. 30, 31, 32*), and in Schizaster (*Pl. XXVI. f. 40*); we may have serrations taking the place of lateral processes, as in Brissus (*Pl. XXV. f. 36, 37*). Another kind of pedicellariæ, which we might strictly call the typical trifoliate pedicellariæ, is characteristic of the Spatangoids proper (*Pl. XXV. f. 26′, 42; Pl. XXVI. f. 24*); the short tridactyle pedicellariæ of Clypeaster recall them to a certain extent. These pedicellariæ are gibbous at the base, contracted in the central part, which is prominently serrated, and terminates with a broad spoon-shaped tip (*Pl. XXV. f. 26′*). In the pedicellariæ of the Spatangoids the soft parts are but scantily developed.

In the greater number of starfishes the pedicellariæ are supported upon comparatively short stems, and are, as in our common starfish (Asteracanthion),

clustered round the base of the spines of the dorsal surface (*Fig. 9*); in some starfishes we also find tripartite pedicellariæ as in sea-urchins, only they are usually supported upon a very short stem, or articulate directly from the limestone network of the shell. We find similarly in Echini pedicellariæ placed in pits (Goniocidaris) in which the stem is reduced to a minimum; their function is quite problematical, and their movements are reduced to the mere opening and shutting of the valves. It is from the study of the pedicellariæ of starfishes that we have been able to form some accurate idea of the homologies of these interesting appendages.

We must now go back to the early history of the growth of spines in embryo Echinoderms, to obtain the key of the homologies of pedicellariæ. In all young Echinoderms the test, i. e. the upper coating of the arms of a starfish, the envelope of a Holothurian, the shell of a sea-urchin, is made up of an irregular network of limestone cells (*Fig. 10*), which makes its appearance

FIG. 9.

FIG. 10.

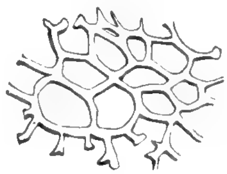


FIG. 11.

in the early Pluteus stages; with increasing size this network becomes closed at certain points, and sends off upright shanks, which little by little form very irregular fan-shaped spines (*Pl. IX. f. 1; Pl. X. f. 4*); in our common sea-urchins these spines are immovable, forming at that stage part of the test itself. As the spines grow they become more pointed (*Pl. X. f. 4*), but are still immovable. In somewhat more advanced stages a slight constriction is formed at the base of the spine (*Pl. X. f. 3*), and very soon after that, below the constriction, a tubercle is formed upon which the spine is articulated, and is then capable of a certain amount of motion by means of the muscular sheath connecting the base of the spine with the tubercle, which fit by a ball-and-socket joint; soon the spine appears longitudinally striated, the limestone cells of which it was composed when smaller becoming obliterated by the successive circular layers of the older spine.

In some sea-urchins (Arbacia) we find spines which never become articulated, are always fixed, and remind us, although of very different shape, of the embryonic stage of the spines of our common sea-urchin (*Pl XXVI. f.*

6, 7). In one of the Echini discovered by M. Pourtalès, the fixed spines cover the whole upper part of the test (*Pl. IV. f. 8, 10, 12, 13*), the movable spines being limited to a circumscribed area along the edge of the shell (Podocidaris).

If we trace the development of the spines of starfishes, we find something similar; but as the pedicellariæ are clustered round the base of the longer spines, we are able to distinguish in the earliest stages what will become a spine and what will eventually form pedicellariæ, — a distinction which it is not possible to make in Echini, where the pedicellariæ and spines are irregularly scattered. This is especially the case in such genera as Arbacia and the like, in which there are so-called embryonal spines remaining always fixed immovably to the test (*Pl. XXVI. f. 6, 7*).

In our common starfish I have traced the earliest stages of the spines and pedicellariæ (*Fig. 11*), and have found that at first it is impossible to distinguish between a spine and a pedicellaria; it is only in somewhat later stages that the first trace of a difference can be detected (*Fig. 12*); subsequently

Fig. 12.

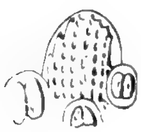


Fig. 13.

Fig. 14.

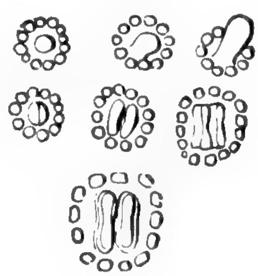


Fig. 15.

there is no doubt whatever, owing to the greater and more rapid development of the central spine, as to what will form spines or pedicellariæ (*Fig. 13*). In one of the pentagonal starfishes of our coast (Hippasteria) it is even easier to trace the gradual passage of the original limestone network, either, on the one hand, into a spine, or, on the other, into bipartite pedicellariæ. In *Fig. 14* we can easily trace the development of a simple central granule, surrounded by smaller granules, into a short spine; or by the splitting of the granule we have gradually formed a slight furrow, then a deeper groove, till two clappers are formed (*Fig. 15*), which eventually become movable, and act as pedicellariæ, though they are the simplest forms of that organ. In another starfish, the genus Luidia, the central granule, surrounded by smaller granules, develops either into a spine which passes through the stages

of *Fig. 16*, and terminates in a long slender spine, surrounded by papillæ at its base; or the central spine of *Fig. 16* is, like the central granule of Hippasteria, little by little split into three, and finally forms a passage through such forms as are given in *Fig. 16*, into short tripartite pedicellariæ, surrounded by isolated spines at the base.

If anything further were required to prove the homology between spines and pedicellariæ. it is the case of tripartite, pedunculated. Echini pedicellariæ attached, as common spines are, upon a tubercle, surrounded by the peculiar smooth area called the scrobicular circle; this form of pedicellariæ is actually found in the genus Podocidaris (*Pl. IV. f. 13*). The same reasoning will readily suggest to the student of Echinoderms the homology of the

FIG. 16.

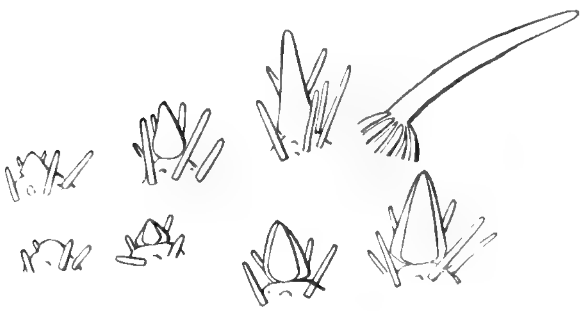


FIG 17

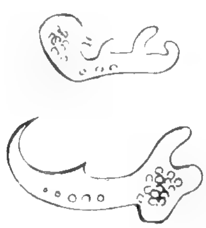


FIG. 18.

so-called claws of Ophiurans (*Fig. 17*) and of the anchors of Holothurians (*Fig. 18*), which, although used for such totally different functions, — a sort of prehensile organ, for motion along the ground, — are in reality in their turn only modified spines, or different forms of pedicellariæ.

Although the spines of our sea-urchin are apparently so different from the pedicellariæ, yet when we pass in review the whole order of Echini we find differences among the spines fully as great as those observed in the pedicellariæ. What can be more diverse than the immense, slender, hollow spine of an Echinothrix (*Pl. III^a. f. 1*), or of a Diadema, six to eight times the diameter of the test, and the short flattened spine, forming a regular pavement on the test of Colobocentrotus (*Pl. III^d. f. 4*); we find such extremes as the club-shaped, curved ambulacral spines of Salenia (*Pl. III. f. 8*); the papillæ of Cidaris; the sharp, solid, curved antennæ-like spines of Coelopleurus (*Pl. II^c. f. 14*); the massive bat-shaped spines of Heterocentrotus (*Pl. III^d. f. 6; Pl. III^c*); the cupuliform spines of Goniocidaris (*Pl. I^g. f. 3, 4*); the slender silk-like spines of the Clypeastroids (*Pl. XIII^d. f. 4; Pl. XIII^c.*

f. 8; Pl. XIII^f. f. 7), and of the Spatangoids (*Pl. XV^a. f. 1; Pl. XIX^b. f. 9; Pl. XXI^c. f. 5*).

In Ophiurans we find all the intermediate stages between plates, claws, and slender spines; in starfishes, between the simplest granules, the most complicated serrated spines and pedicellariæ; and in Holothurians, between mere spicules, anchors, and the pavement-like covering of such genera as Cuvieria and Psolus. All this shows plainly enough that the spines and pedicellariæ are strictly homologous, whatever modifications they may assume in the different orders of Echinoderms, whether they serve as prehensile scavengers, or simply protect the test against the violence of the waves on the rocks or the attacks of their enemies. Sea-urchins are the favorite food of many species of fish; they would find it rather dangerous to attack the bristling Diadema, and require pretty strong jaws to get the better of the armored Heterocentrotus. The spines are not simply organs of defence; they also act as means of locomotion, and in such genera as Arbacia the ambulacral suckers perform only a secondary part in the displacement of the sea-urchin, the spines of the lower side serving as stilts by which the sea-urchin raises itself and moves along by a kind of halting gait. In Ophiurans and Holothurians, the pedicellariæ hooks and anchors perform the part of organs of prehension and locomotion at the same time.

There is nothing in the history of the development and in the homologies of these organs to show that they have been suddenly brought into existence; on the contrary, the modifications of the spines and pedicellariæ show the most complete homology between appendages which have lately been considered as strong proofs of the possibility of the sudden appearance of organs for which no utilitarian motive could be given. I trust I have made it sufficiently plain that in the most complicated pedicellariæ known, with a freely movable stalk and with snapping jaws, we have only a very gradual modification of the simplest sort of limestone network found in all Echinoderms, in the earliest stages of the embryonic development, while still in the Pluteus stage, and that we have an unbroken sequence from this primitive network to form, on the one side, the most diversified spines, and on the other equally variable pedicellariæ, and that we must consider the latter in their most complicated forms as nothing but highly specialized spines.

SPHÆRIDIA.

In addition to their well-known outer appendages, the recent Echini, with the exception of Cidaris, possess external organs which have only lately been detected by Lovén; he calls them Sphæridia.*

They are small button-like bodies, — spheroidal, ellipsoidal, or somewhat irregular balls, furnished with a short stalk, movable upon slightly projecting tubercle. The sphæridia are hyaline, shining, hard, solid, clothed with connective tissue rich in pigment, with epithelium and a ciliated cuticle. Their pedicel has the reticulated texture typical of the Echini, which spreads more or less distinctly and continuously around its starting-point. In the direction of the axis of the ball we not unfrequently see a tube which opens in its upper pole, and is either simple or branched in a more or less regular manner. A great many of the balls have on their surface small elevations, tubercles, or spines, and many also depressions, which are sometimes shallow, but frequently sink deeply in towards the axis in a conical form. But the greater mass of the ball is formed of very numerous and very thin concentric layers, and there are some which do not present anything but these. Their solid contents are dissolved by a weak acid.

The sphæridia belong exclusively to the ambulacra, and in all the genera where they occur they are found in the peristomal plates. They always occupy a definite position. In the Spatangidae they stand generally uncovered; one, two, or more in a little group by the base of the tentacular cirri of the buccal area, near the side turned toward the median suture of the ambulacra, decreasing thence the farther from the mouth, especially on the bivium, — not unfrequently four, three, or two upon each of the first plates, only one on each of the ordinary plates immediately following; more numerous on the trivium, in depressions or like rows of beads in narrow, elongate, well-defined furrows. In Lovenia the segregated sphæridia are concealed under domes, which have a small, narrow, transverse opening at their apex.

* The following abbreviated account is taken from the translation by Dallas, in Ann. and Mag., Oct., 1872, of Lovén's article in the Oefversigt of Kongl. Vet. Akad. Förhandl., 1871.

A covering of this kind, which is the exception among the Spatangoids, is the rule in the Cassidulidae and Clypeastridae. Rhynchopygus has, on every plate of the first five pairs in each ambulacrum, a sphæridium which is gradually overgrown by the outer layer of the test, and which leaves finally only a fine fissure open. (See *Pl. XV. f. 3; Pl. XV^a. f. 2*),

The Clypeastridae exhibit two types. Echinarachnius, Lobophora, Mellita, Encope, Rotula, Laganum, and Echinocyamus have in each radius only a single sphæridium in common for both of its peristomal plates, and most frequently, even in very young individuals, concealed in a crypt in the mass of the shell. In Clypeaster and Arachnoides we have two sphæridia in each ambulacrum, one in each of its two peristomal plates. Echinoneus has, near the tentacular pore on the first and second plates, segregated globular sphæridia, which are seated in uncovered slight depressions. In this, as in much else, they resemble the regular Echini.

In the regular Echini the sphæridia are numerous, and distributed alternately on both rows of plates of the ambulacra. In the Echinidae proper they stand near the sutures of the plates; in the Diadematidae, near the tentacular pores. In the Arbaciadae each ambulacrum has only a single sphæridium in a round notch in the suture close to the margin.

These organs, which are so well and peculiarly protected in many genera, cannot be anything but a sensorial apparatus, probably destined for the perception of the changes which take place in the surrounding water, and in the substances which they hold in solution or suspension; consequently an organ of taste. The sphæridia make their appearance seemingly later than the spines and pedicellariæ.

I have to thank Professor Lovén for preparations showing the sphæridia of several genera.

ALIMENTARY CANAL.

THE alimentary canal of Echini consists of an œsophagus, a so-called stomach proper, and a terminal intestine leading to the anal opening. In the Desmosticha and Clypeastroids the œsophagus is further specialized; at the entrance of the actinostome it is divided into a narrow canal, situated entirely within the pyramids of the jaws; this narrow œsophagus is more or less pentagonal near the actinal opening, strongly ribbed by five longitudinal bands with folds intermediate between them,* extending from the five basal lips attached to the teeth proper, and the junction of the narrow œsophagus with the œsophagus proper. In the Desmosticha the alimentary canal (if we place the test so that it winds, after leaving the upper part of the pyramid, from left to right) follows the outline of the test, making a complete circuit; it then turns upward towards the abactinal pole, and curves back again in the opposite direction, forming a second circle round the test from right to left. These circles are not simple circles, but successive loops pointing towards the apical system in all the interambulacral spaces, and towards the actinostome in the ambulacral spaces. These loops thus form two concentric series, extending round the test (*Pl. XXVII. f. 1, 3, 4, 5; Pl. XXVIII. f. 5*), and terminating in the narrow terminal anal intestine, which runs obliquely towards the apical system to the anal system (*Pl. XXVIII. f. 3, 6, a*).

The alimentary canal is kept in position by minute, flat-pointed appendages on the edges of the canal, firmly attached to the inner surface of the test. These points occur at regular intervals, and are particularly well shown on *Pl. XXVII. f. 5; Pl. XXVIII. f. 3, 6;* towards the abactinal part of the alimentary canal they coalesce, and gradually pass into a rounded thread, which follows the course of the alimentary canal (*Pl. XXVII. f. 3, 4*). The terminal intestine flares, somewhat trumpet-shaped, immediately below its point of attachment to the anal system, to which it is attached by prominent radiating bands, similar to the mesenteries of the actinal part of the alimentary canal (*Pl. XXVIII. f. 3, 6*). The upper part of the œsophagus is remarkable for the papillæ, which cover the whole exterior surface (*Pl. XXVII. f. 1, 5*).

* VALENTIN, Anatomie du Genre Echinus, *Pl. VII. f. 124.*

We can distinguish in the walls of the alimentary canal an outer and inner connecting layer, enclosing a transverse and a longitudinal muscular layer.

Although at first sight the general course of the alimentary canal appears totally different in the Clypeastroids and in the Petalosticha from that of the Desmosticha, we do not find on ultimate analysis such a wide difference.

While examining the course of the alimentary canal from the point at which it leaves the pyramid in the Desmosticha, it was placed in such a way that, when seen from above, the first winding should be from left to right along the test. This does not place the different genera in a homologous position, as in one case we may have the first loop of the alimentary canal so placed as to be nearest what in one genus would be the left anterior ambulacrum, and in the other the left posterior ambulacrum, if we determine these ambulacra by the position of the madreporic genital; in all the genera I have examined the alimentary canal trends from the pyramid to the interambulacral space in which the madreporic body is placed. On determining whether this has a definite relation to the anal opening, we find that it is placed nearer a trivium, but not the same trivium, in different genera. If we now take the trend of the terminal intestine as our guide, we find that although the relative direction of the terminal part of the alimentary canal and of the origin does not correspond with that of the irregular Echini, yet, in the Desmosticha, if we place one of the ambulacra in the prolongation of the direction of the anal termination of the alimentary canal, the madreporic body will always be in the left posterior interambulacral space. The above position of the Desmosticha, with the madreporic body in the left posterior interambulacral space, is the only one properly homologous to that of the Clypeastroids and Spatangoids, in which we always find the odd ambulacrum in the prolongation of the trend of the terminal anal part of the alimentary canal.

In Clypeastroids the pyramidal œsophagus is quite slender; it opens into a flat triangular pouch, the broad œsophagus which runs in the trend of the longitudinal axis (*Pls. XXVIII., XXIX. lower figs.; Pl. XXX. upper fig.*); at its junction with the alimentary canal proper it turns sharply round to the left, and runs back along the edge of the test, past the posterior extremity, completely round the ambitus to the anterior edge, where it forms a second loop, and runs back again on the inside of the outer part of the alimentary canal to the anal opening (*Pl. XXXVIII. f. 1, 2, XXIX. lower fig.; Pl. XXX. upper fig.*).

The terminal anal extremity of the alimentary canal does not differ materially in some Clypeastridae from the rest of the canal (*Pl. XXVIII. f. 2; Pl. XXIX. lower fig.*); in the Scutellidae it is often remarkably slender (*Pl. XXXI. f. 2*). The alimentary canal is separated by pillars or by continuous walls from the actinal cavity, and also from the ambulacral system; the arrangement and structure of these walls and pillars giving excellent features to distinguish generic groups, when taken in connection with the marginal pillars and walls uniting the two floors. In Echinocyamus the marginal partitions radiate from the ambitus to the actinostome (*Pl. XIII. f. 7*), and there are no walls separating the digestive cavity from the ambulacral system or the actinal cavity. In the Laganidae (*Pl. XXXIII. f. 3, 4; Pl. XIII^e. f. 10, 11*) the marginal supports form disconnected walls, concentric with the outer edge, without separating the alimentary canal from the actinal cavity. In the Scutellidae we find the marginal supports usually in the shape of radiating pillars (*Pl. XIII^c. f. 3; Pl. XII^b. f. 6; Pl. XIII^a. f. 1, 2, 5*), and in some genera the first trace of small pillars (*Pl. XII^a. f. 4*) appears (*Pl. XIII^d. f. 1*), between the marginal pillars and the auricles. This system of pillars is more and more complicated in some of the Scutellidae (*Pl. XI^d. f. 3*), Encopidae (*Pl. XII^b. f. 3, 4*) and Echinanthidae, till it finally entirely separates the alimentary canal from the remaining internal cavity of the test (*Pl. XI^b. f. 2, 4; Pl. XI^c. f. 3, 4; Pl. XXVIII. f. 2*).

The mesenteries which hold in place the alimentary canal are few in number, generally reduced to a simple chord following the alimentary canal, as in the abactinal part of the alimentary canal of the Desmosticha (*Pl. XXVIII. f. 1; Pl. XXX. upper fig.*), and in this case it follows nearly the course of the main vessel following the alimentary canal.

In Desmosticha the alimentary canal is filled with particles of algæ, those towards the anal part are formed into pellets (*Pl. XXVIII. f. 5; Pl. XXVII. f. 1, 3*), and as such pass out of the anal opening, while nearer the actinostome the contents form a homogeneous mass of minutely ground particles of seaweed and the like. In the Clypeastroids the alimentary canal is, as in the Petalosticha, filled with sand in spite of the presence of jaws and teeth. The majority of Clypeastroids live upon sandy shores, and use their jaws simply to force in the sand by a process of shovelling; they do not browse habitually on seaweed growing upon rocky shores, as the regular Echini do. This is probably due to their comparative helplessness and incapacity of locomotion, which they share with the Petalosticha. It is difficult

to imagine why the more highly organized Spatangoids, which stand at the top of the scale of Echinoids should be the most helpless and least capable of protecting themselves and of choosing their food; while the Desmosticha can readily change their locality, and are by nature infinitely better protected against the attacks of their enemies than the comparatively helpless Spatangoids, whose main reliance against destruction consists in burrowing in sand-banks, and, by becoming more or less covered by sand, thus escape the notice of their enemies. The Spatangoids have reached such a state of Echinoid perfection that their ultimate disappearance is clearly foreshadowed!

In Rhynchopygus we find the simplest form of alimentary canal observed in Petalosticha. Owing to the delicate nature of the walls of the alimentary canal of Spatangoids, it is almost impossible to follow its course in alcoholic specimens. The walls are invariably broken through by the weight of sand which fills the canal. Careful preparations must be made from living specimens to be able to follow its course. A few such preparations I was able to make at Acapulco on Rhynchopygus; they will enable us better to understand the more complicated structure of Spatangus as given by Hoffman in his excellent monograph on the anatomy of Spatangus purpureus. I have freely copied from his memoir the data to elucidate that part of the anatomy of Spatangoids, as we have no common Spatangoid very available on our coast for study in a fresh condition. The comparative study of Rhynchopygus, Spatangus, and the Clypeastroids will show a far closer general identity in the structure of the alimentary canal than could have been traced from a comparison of Spatangus with the Clypeastroids directly.

In Rhynchopygus the œsophagus is quite narrow, trends slightly to the left of the odd anterior ambulacrum (*Pl. XXXII. f. 5*), takes a sharp turn upwards and opens into a wide alimentary canal (*Pl. XXXII. f. 3*), which bends back towards the posterior extremity, running from left to right completely round the edge of the test till it reaches the anterior extremity again. It then makes a second sharp turn upwards and backwards, running again towards the posterior extremity, completely round the edge of the test till it nearly reaches the anterior extremity; it then curves towards the central longitudinal axis, and, turning completely round, runs in a straight line to the anal opening, which it reaches as a narrow tube compared to the broad pouches which made the last circuit of the test (*Pl. XXXII. f. 1*). At the

junction of the œsophagus with the broad intestine (*Pl. XXXII. f. 5*) we find a cluster of diverticula, in the form of pointed pouches. Seen from the actinal side, a simple mesentery unites the interior edges of the alimentary canal (*Pl. XXXII. f. 3*). The outer edges of the canal, which follow the edge of the test, are attached by delicate mesenteries; their course can be traced on the interior of the test (*Pl. XXXII. f. 2; Pl. XXXIII. f. 2*).

In the Petalosticha the trend and course of the alimentary canal appear to vary greatly, and may prove of value as systematic characters. In Spatangus (*Pl. XXXII. f. 17, 18*, copied from Hoffman) the commencement of the alimentary canal runs in the posterior interambulacral space, rising slightly towards the apical system, trending to the right; it runs then from right to left, rising very gradually until it has reached the anterior extremity of the test, where a huge diverticulum, trending upwards and towards the posterior extremity, arises. It continues to run parallel to the test, forming a nearly complete circuit, till it nearly reaches the anterior extremity. It then curves sharply upwards, running backwards from right to left towards the posterior extremity, completing somewhat more than a half-circuit; it then forms a sharp curve towards the central part of the cavity, becoming much wider at the same time, and, when it has reached the longitudinal axis, suddenly narrows and extends to the anus in the posterior interambulacral space, immediately above the place of its origin, only in the abactinal part of the test. We can distinguish, as in the Desmosticha and Clypeastroids, an œsophagus, a broad part of the alimentary canal, and a terminal anal extremity. The alimentary canal is attached to the test by innumerable minute mesenteries. Distinct traces of the course of this attachment can still be seen (*Pl. XXXIV. f. 2*) on the interior of the abactinal part of the test, as in the regular Echini; but in addition to these we have large mesenteries which connect the central parts of the alimentary canal, and are not found either in the Desmosticha or in the Clypeastroids.

In Metalia the trend of the œsophagus follows the line of the posterior interambulacral field (*Pl. XXXII. f. 11*). It consists at first of a large triangular actinal pouch, passing gradually into a narrow œsophagus. At the junction of the œsophagus with the alimentary canal proper is found a cluster of small diverticula resembling those of Rhynchopygus, and not a single large diverticulum as in Spatangus proper.

The mesenteric plates holding the alimentary canal in place are more complicated in Spatangus than in Rhynchopygus, where the only prominent

one is the actinal plate (*Pl. XXXII. f. 3*), while in Spatangus we have an actinal and an abactinal mesenteric plate, both of which consist of a larger and a smaller plate. The smaller actinal plate commences to the left of the solid actinal mesenteric supporter, and reaches the œsophagus on the right. The other larger actinal mesenteric plate covers the whole solid support from which it originates, covering the smaller plate, and follows the winding of the alimentary canal from the junction of the œsophagus to the point where the returning curve of the alimentary canal commences. The dorsal mesenteric plates commence, the smaller one on the posterior left side of the actinal support, following the terminal upper end of the alimentary canal to the anus; the larger plate on the right of the actinal support, also following the edge of the alimentary canal to the anus, and extending under the diverticulum to the returning curve of the alimentary canal, where the actinal and abactinal mesenteric plates meet.

Hoffman has discovered in Spatangus a remarkable organ, which he calls the "gewundene organ," the function of which is entirely unknown (*Pl. XXXII. f. 18*). It consists of a long tube, somewhat winding, partly following the course of the large actinal mesenteric plate; it is open at the two ends leading into the alimentary canal, thus forming, as it were, a second smaller alimentary tube. This organ had escaped the notice of all former observers excepting, perhaps, Milne-Edwards, who describes a sort of heart connected with the actinal vessel following the course of the actinal mesenteric plate. In Spatangoids, as in Desmosticha, we distinguish an inner and an outer layer, and a transverse and a longitudinal muscular layer. The diverticulum probably acts in Spatangoids as an organ of secretion.

The spicules of the alimentary canal and of the genital organs were first noticed by Valentin. They consist usually of simple bihamate spicules and of perforated and reticulated plates of considerable size, with irregularly indented margins, extremely variable in shape (*Pl. XXXVIII.*). To Stewart we owe a more extended notice of the spicules of the alimentary canal and ovaries (*Pl. XXXVIII. f.* 12^{a-h}), which he considers will afford valuable hints for generic and even specific distinctions. As far as my observation goes, I have found these spicules of little value beyond identifying the more extensive groups. The envelope of the genital organs frequently contains large perforated plates, forming sometimes, as in the case of the Cidaris, a regular mailed casing to the ovarian tubes. In the walls of the alimentary canal, although plates are sometimes found (*Pl. XXXVIII. f.* 2^{a-c}), the

spicules proper are more common, and are especially numerous in the mesenteries and the enclosing wall of the pyramid of the jaws.

Hoffman has been the first to call attention to a peculiar calcareous support found in Spatangoids, situated near the actinostome, on the inner surface. It consists of an irregularly shaped triangular or rectangular projection of the test, placed in the left posterior interambulacral space (*Pl. XXXIV. f. 2, 4*), from which the main mesenteries of the alimentary canal take their origin. This support seems peculiar to the Spatangina, and is not to be homologized with the prominences of the interambulacral spaces next to the actinostome in Nucleolidae (see *Pl. XV. f. 1; Pl. XXXIII. f. 1*); these appear, judging from the mode of formation of the auricles of some Clypeastroids, to be rudimentary auricles. The auricles of those Scutellidae in which the reticulation of the inner actinal floor is very marked (*Pl. XIII^c. f. 3*), shows that they are mere processes of the interambulacral plates (see also *Pl. XII^a. f. 4; Pl. XIII^a. f. 5; Pl. XIII^b. f. 6*).

GENITAL ORGANS.

In all Echini the genital organs open outwardly through ovarian openings situated in the apical system, immediately above the apical extremity of the interambulacral spaces, between the origin of the poriferous zones. There are usually five ovarian openings in all Desmosticha; passing through large prominent plates, they lead into as many genital organs, consisting of clusters of ovaries or of spermaries. There is no difference in the shape of the genital clusters between the males and the females, beyond the difference in coloring noticed at the time of breeding, when the genital organs are fully expanded. The ovaries are then usually colored yellowish-brown, while the spermaries are of a milky tint; they consist of a main tube branching into a number of diverticula filled with eggs or spermaries. In the Desmosticha the genital organs, at the breeding time, fill the whole of the free space between the test and the alimentary canal in the interambulacral spaces (*Pl. XXVII. f. 4; Pl. XXVIII f. 4*), and the space enclosed within it (*Pl. XXVII. f. 3; Pl. XXVIII. f. 5*), completely surrounding and encasing the alimentary canal. During the growth of the genital organs they extend as clusters between the test and the alimentary canal (*Pl. XXVII. f. 2*) only in the interambulacral spaces; even at the time of breeding the ambulacral fields are kept free (*Pl. XXVII. f. 4; Pl. XXVIII. f. 4*).

In the Clypeastroids the genital organs extend over the abactinal part of the alimentary canal (*Pl. XXVIII. f. 2; Pl. XXIX.*), forcing their way under the inner edge of the outer turn of the alimentary canal, and appearing on the actinal floor (*Pl. XXVIII. f. 1; Pl. XXX.*). The course of the alimentary canal can be traced by the compression of the ovaries along its path (*Pl. XXIX. upper fig.; Pl. XXX. lower fig.*). In genera with radiating walls or walls parallel to the outer edge, the ovaries force their way between them, completely filling the intervening spaces (*Pl. XXXI. f. 2*).

In the Petalosticha the genital organs occupy a much more limited space even at the time of breeding (*Pl. XXXII. f. 2, 12*), being reduced usually to four small clusters in the abactinal part of the test. In all Petalosticha the genital openings are limited to four, the odd posterior genital opening is

wanting, the lateral posterior genital organs are more fully developed than the anterior ones (*Pl. XXXII. f. 2, 12*), and the right anterior one is the least developed (*Pl. XXXII. f. 2, 12*). In those genera in which there are only three genital openings it is usually the right genital opening which disappears first, and when there are only two genital openings, the posterior pair alone is left. Something analogous can also be traced in the Desmosticha (*Pl. XXVII. f. 2*), in which two of the genital organs, the posterior ones, are more fully developed than the others. The same is the case in the Clypeastroids; the posterior genital organs are usually the largest. The genital organs in the Petalosticha are attached to the test by delicate membranes extending from the abactinal part of the genital organs; in *Pl. XXXIII. f. 2*, the scars left by the delicate mesenteries, can be seen in the interambulacral spaces. For the structure of the egg see the chapter on the Embryology of the Echini. The spermatozoa consist, according to Kölliker and Peters, who have described them, of a minute head with a long slender tail.

OCULAR SYSTEM.

Intercalated between the genital plates, at the abactinal extremity of the ambulacral system, are five plates smaller than the genital plates, which have received the name of ocular plates. They are more or less polygonal, and from their relative positions between the genital and anal plates important generic characters have been derived. These plates are perforate, allowing the passage of an odd tentacle ; this is the homologue of the odd ocular tentacle of starfishes, and although no eye-specks have as yet been discovered in these odd tentacles, they are, from their position at the end of the ambulacral tube, undoubtedly the homologue of the ocular tentacles of the starfish. For a detailed account of the odd tentacle and its probable homology, as well as the interpretation of the ocular plates, I would refer to the description of the young Echini. In the Desmosticha and the Clypeastroids the ocular plates are more prominent than in the Petalosticha.

ANAL SYSTEM.

In all the Desmosticha the anal system is enclosed by the genital and ocular ring. It consists of a series of polygonal plates, usually irregularly arranged, becoming smaller towards the anal opening, round which they are minute, lapping so as to close the opening completely (*Pl. VII. f. 19; Pl. VIII. f. 24'*). In the Diadematidae the anal system is quite large, covered by a nearly bare membrane (*Pl. III^a. f. 3*), strengthened round the base by plates (*Pl. II^b. f. 6, 7*). The anal opening is placed at the extremity of a conical tube projecting far beyond the general level of the anal system (*Pl. II^c. f. 6; Pl. III^a. f. 1, 4; Pl. III^b. f. 5*). As I have shown in my Embryology of Echinoderms,* the anal system in the very youngest stages is covered with only a single plate (*Pl. VIII. f. 10; Pl. X. f. 2*); other anal plates are subsequently added, but the original large anal plate frequently retains its prominence in full-grown specimens (*Pl. VIII. f. 3; Pl. VIII. f. 24'*), while in those genera in which the anal system is covered by a limited number of anal plates, as in Arbaciadae (*Pl. V.*), Parasalenia (*Pl. III^d. f. 2*), Trigonocidaris (*Pl. IV. f. 1*), the number does not vary with age.

Judging from the study of the recent species alone, the contrast between an anal system connected with the apical system, as in the Desmosticha, and the independent anal and genital systems of the Clypeastroids and Petalosticha seems very striking. There are some fossil genera, Pygurus and Galeropygus, which, when better known, may show how the anal opening becomes gradually disconnected from the genital ring, as in both these genera the anal plates must have been in contact exteriorly with the genital ring. The anal system is less prominent in the Clypeastroids than in either of the other suborders, and is usually reduced to a small insignificant opening covered by small plates, the position of which is extremely variable (see *Pl. XI. f. 17; Pl. XI^b. f. 2; Pl. XI^e. f. 1, 4; Pl. XII^b. f. 4; Pl. XII^c. f. 2, 4; Pl. XII^d. f. 4; Pl. XIII^b. f. 2, 5; Pl. XIII^c. f. 2, 7; Pl. XIII^f. f. 2*). In the Petalosticha the anal system is usually large, very prominent; the arrangement of the plates furnishing excellent characters for discriminating

* A. Agassiz, Embryology of Echinoderms, Mem. Am. Acad., 1864.

species. The membrane is covered by large, more or less polygonal plates, becoming smaller towards the anal opening. As is the case in the Diadematidae, the anal opening is sometimes placed at the extremity of a tube projecting beyond the level of the test (*Pl. XVII. f. 4, 6*). In one of the families of Spatangoids, the Leskiadae, we find a limited number of anal plates; in Paleostoma the anal plates (*Pl. XXXII. f. 15*) form a conical projection, and are not arranged, as in the other Petalosticha, in concentric rows decreasing in size towards the anal opening. See Part III. p. 582.

In the Salenidae the larger plates covering the anal system become soldered to the plates of the genital ring, while the minute plates which immediately surround the anal opening are movable and do not differ from the anal plates of the other Desmosticha. See *Pl. III. f. 11*, and p. 258 of Part II., for the description and discussion of the relationship of the apparently abnormal apical system of this family.

Among Spatangoids proper we never find more than four genital openings. The central plate, which carries the madreporic body, becomes completely united with the fifth imperforate genital plate. We thus find the structure of the apical system passing through its simplest form as typified among the regular Echini, in which the anal system forms a component part of the genital and ocular systems, to the anal system of the Clypeastroids and the Spatangoids, which becomes isolated from the genital and ocular rings; in the former we still have left what we may consider the analogue of the large primary anal plate of young regular Echini, which becomes the madreporic plate, and is isolated from the genital plate; this may be perforated or not: in Spatangoids this genital plate never has a genital opening, and always carries the madreporic body.

The position of the madreporic body cannot, I think, be taken to indicate, either in the regular Echini or in starfishes and Ophiurans, the position of an anterior extremity. If we examine the position which the madreporic body holds with reference to the winding of the alimentary canal in Spatangoids and Clypeastroids, we find that it may be either to the right or to the left of the longitudinal axis, as defined by the position and direction of the alimentary canal, leading from the mouth either towards the anterior or towards the posterior extremity of Spatangoids and Clypeastroids, as fixed by the odd anterior ambulacrum. See *Pl. XXXII. f. 5, 11*, in which the œsophagus, when leaving the actinostome, trends in one case in the direction of the odd anterior ambulacrum, and in the other in the direction of the odd posterior interambulacral space.

In some of the Spatangoids the abactinal system becomes very elongated, by the great increase in breadth of the lateral posterior interambulacra near the apical system. This is carried so far that in some of the fossil families — Dysasteridae and Ananchytidae — the genital and ocular plates of the trivium and the bivium become completely disconnected by the junction of the apical plates of the lateral posterior ambulacra of opposite sides of the test, thus forming two independent apical systems. We find a gradual passage between the compact abactinal system of such recent genera as Schizaster, the Brissina, and the like, to the disconnected apical system of the Dysasteridae, through such fossil genera as Cardiaster, Holaster, Ananchytes, where the plates of the apical system gradually become arranged in two parallel lines, the ocular and genital plates alternating; the system ending at the anterior extremity in an odd ocular plate, and at the posterior one in two posterior ocular plates.

ACTINOSTOME.

THERE is a marked difference in the position of the actual opening of the mouth in those Echini which have teeth, as in the Desmosticha and Clypeastroids, and in those which are edentate, as in the Petalosticha. The actual mouth is a circular opening of the actinal membrane, from which the five jaws protrude (*Pl. VII. f. 20*); the actinal membrane fitting closely to their outer sides, while on the inner side, within the jaws, where the teeth are attached to the pyramid, is found the inner opening, formed by the attachment of the continuation of the walls of the alimentary canal within the pyramid. This continuation forms a sort of œsophagus, which in the toothed Echini is placed either wholly or in part within the pyramid of the jaws, and separates the peristomal cavity from the exterior. This short œsophagus is only attached at the extremity, and is separated from the upper part of the pyramids, leaving them full play for motion (*Pl. XXVII. f. 1, 5*). Valentin has given an excellent figure of the intestine separated from the pyramid, on *Pl. VII. f. 122* of the Anatomie du Genre Echinus. In the Clypeastroids, owing to the shorter height of the jaws, this œsophagus is quite rudimentary, but the mode of attachment of the inner mouth membrane and of the actinal membrane to the pyramids is the same as in the Desmosticha (*Pl. XXIX. lower fig.*; *Pl. XXXVIII. f. 1, 2*; *Pl. XXX. upper fig.*).

In Spatangoids the opening of the actinal membrane leads directly into the œsophagus through a more or less conical pouch (*Pl. XXXII. f. 5, 11, 17*) in which we do not find the muscles and folds so characteristic of this part of the digestive canal in the toothed Echini. The actinostome of some of the Spatangoids consists of a transversely elliptical opening, in which an upper and a lower lip can be (*Pl. XIX^a. f. 5, 6, 8, 9*) distinguished; the actinal membrane is covered by large polygonal plates, leaving a small mouth-opening; the plates are largest near the anterior extremity, becoming smaller and frequently very minute near the actinal opening (*Pl. XXI^a. f. 3*; *Pl. XXXII. f. 11*; *Pl. XXXIV. f. 2, 4*). By the movement of the upper lip the actinal opening can be increased or decreased, and even closed. The upper and lower lips of the actinostome are well marked in such genera

as Faorina (*Pl. XIX^a. f. 5, 6*), Linthia (*Pl. XIX^a. f. 8, 9*), and Brissus (*Pl. XXI^a. f. 2, 3*); less marked, and at the same time the opening is more circular, in Breynia (*Pl. XV.^{a} f. 8, 9*), Eupatagus (*Pl. XV^a. f. 3, 4*), and Platybrissus (*Pl. XXI^b f. 3, 4*); while in the Cassiduloids, in which the actinostome has become pentagonal, the sides are all on one level (*Pl. XV. f. 3*), and the actinal membrane is covered by a coating of numerous small plates, leaving a central opening (*Pl. XVI. f. 9*). In some genera the interambulacral spaces between the phyllodes are crowded with minute tubercles, forming what are called bourrelets (*Pl. XV^a. f. 2; Pl. XV. f. 6*), or the ambulacra remain simple pairs of pores, as in Echinonëus (*Pl. XV^a. f. 6*), round the actinostome, forming an approach to the structure of the true Clypeastroid actinostome. A very anomalous structure of the actinostome occurs in Paleostoma, where the actinostome is pentagonal, and covered by a small number of plates radiating from the actinostome (*Pl. XXXII. f. 14*). See Part III. p. 582.

JAWS.

In the Desmosticha the jaws are composed of the pyramid, the brace, the rotulæ, the compass, and the teeth.

The pyramid (*Pl. II^a. f. 1, 2, 15–18, 49–51, 34–37*) has an outer concave side and two flattened sides, forming the hollow groove in which the tooth runs. The pyramid is so placed that its vertex is near the actinostome. The pyramid is divided by a longitudinal suture, and it either has a solid face at its upper extremity, as in the Cidaridae (*Pl. II^a. f. 1*), or its upper part is more or less open, occupied by a wide triangular foramen in the other Desmosticha (*Pl. II^a. f. 15, 35*). The prolongation of the abactinal part of the lateral part of the foramen (its apophyses) either forms a closed arc in Echinidae proper, or an open one in different families (Cidaris, Arbaciadæ, and Diadematidae). The lateral faces are lamellæ laterally striated (*Pl. II^a. f. 17, 36*), enclosing a cavity which occupies the greater part of the abactinal part of the pyramid, the lower part of the pyramid alone forming the solid guide for the tooth. This structure is best seen in *Pl. II^a. f. 34*, in which one of the lateral faces of the pyramids is removed. The brace is placed between adjoining pyramids; it is a lengthened flat piece (*Pl. II^a. f. 9, 10, 28–30, 40–42*) below the level of the compass, which is placed with its convex side uppermost (*Pl. II^a. f. 9', 31–33, 43–45, 57*), the single point towards the centre of the pyramid and the fork outward. The Lantern of Aristotle, as the whole masticatory apparatus is called, is composed of five pyramids, made up of two halves, the five braces, the five teeth, and the five compasses, which, as shown by Meyer, are made up of two pieces soldered together. The teeth are composed of two parts, — one the tooth itself; the other the upper soft part, the matrix of the tooth. The teeth of the Desmosticha are either simply grooved, as in Cidaris and Diadema (*Pl. II^a. f. 12, 47*), or else keeled in the middle, as in Arbaciadae and Echinidae (*Pl. II^a. f. 26, 27, 59, 60*). In the Clypeastroids the jaws have the same general structure, only we find that the compass is wanting (*Pl. XI^a.*). The true structure of the jaws of Clypeastroids was early known; Parra, in his Hist. Nat. de Cuba, having already given a correct description of them. As far as I

have examined the jaws of the Clypeastroids I find they differ mainly, as Müller has already shown, in their manner of articulating upon the auricles. The rotulæ are placed upon the sutures of adjoining pyramids (*Pl. XI^a. f. 4, 6*), and are made up of three minute plates. The greatest variation in the shape of the jaws consists in their great height, as in Clypeaster and Echinanthus (*Pl. XI^a. f. 1 – 8*), or in their extreme flatness, as in the Scutellae proper and in Echinodiscus (*Pl. XI^a. f. 9 – 13*). The teeth are placed in a groove of the pyramid, as in the Desmosticha. Müller is of the opinion that it is to the rotulæ of the Clypeastroids that we must compare the calcareous ring of the Holothuriae, as it is near these rotulæ that the ambulacral canals open outwardly; the Holothuriae thus would want the pyramids and the teeth: it also follows, from Müller's careful analysis of the mouth papillæ of Ophiurans, that they are in no way homologous to the jaws of Echini.

The pyramids of Clypeastroids are triangular, flattened; the outer side, however, forming a re-entering angle (*Pl. XI^a.*), so that the junction of adjoining pyramids forms the apex of the pentagon of the jaws, and there the rotulæ are placed; — see the figs. of Echinodiscus auritus, seen in profile and from above (*Pl. XI^a. f. 9, 12*), which show the position of the rotulæ. The mode of articulation of the jaws upon the auricles is entirely distinct in the Clypeastroids and in the Desmosticha; in the Clypeastroids the auricles are disconnected (*Pl. XI^b. f. 4; Pl. XII^a. f. 4; Pl. XIII^a. f. 5; Pl. XIII^b. f. 6; Pl. XIII^c. f. 3; Pl. XIII^d. f. 1*), and when the jaws are in place they completely hide the auricles upon which they ride, as in *Pl. XI^c. f. 4; Pl. XII^b. f. 3, 4; Pl. XXVIII. f. 1, 2; Pl. XXIX. lower fig.; Pl. XXXIII. f. 3*. In the Desmosticha, on the other hand, the jaws are placed entirely within the line of the auricles (*Pl. XXVII. f. 1, 5*), from which they are supported by a very complicated set of muscular bands, extending in pairs from the sides of the auricles, from their base and from the intervening spaces, to different points of the pyramid and of the braces; thus the jaws of all Desmosticha are capable of considerable motion. The greater part of the jaws is, as is well known, surrounded by the membrane of the lantern (*Pl. XXVII. f. 1, 5*); this membrane is in the Clypeastroids reduced to the small bursiform appendages of the inner part of the pyramid. The muscular system of the jaws of Clypeastroids is reduced to a very feeble band attached to the under side of the pyramids and extending to the auricles.

The auricles are interambulacral processes; they are developed from the test itself, and do not belong to the dental system, as stated by Lovén, while the teeth and jaws are developed independently as isolated pieces in young Echini (*Pl. IX. f. 2*). In the Cidaridae the processes of the adjoining interambulacral auricles are closely connected, and appear to be more intimately related than in the Desmosticha proper, where the interambulacral processes on each side of the intervening ambulacral space form an arch, which may or may not be closed, and of which the extremity is more or less closely soldered together (compare *Pl. II^b. f. 3, 5*, Dorocidaris, to *Pl. II^b. f. 9, 10*, Diadema). The last trace of what is evidently the homologue of the auricular processes of the Desmosticha and Clypeastroids is found in the interambulacral protuberances existing round the actinostome on the inner side of the test of the Nucleolidae (*Pl. XXXII. f. 5; Pl. XXXIII. f. 1*).

The microscopical structure of the jaws has been shown by Valentin to be similar to that of the other parts of the test. The teeth, however, are composed of long, slender, narrow plates, composed in their turn of long, slender prisms, slightly curved at the extremities, while the outer sheath is formed of limestone plates, arranged irregularly between and across the component prisms of the teeth proper. The histological components of the muscular tissue of Echinoderms is but little known; according to Leydig* the muscular fibres consist of rather large wedge-shaped bodies, closely packed together, and surrounded by a delicate membrane. Kölliker† has described the muscles of the jaws of Echini as made up of needles of transversely striated muscular fibres. It is remarkable that the muscular structure of the Ophiurans and starfishes should be so different from that of the Echini, if the observations of Schwalbe ‡ are correct.

* Archiv. f. Anat. u. Phys., 1854.

† Würzburg Verhandl., 1858, VIII.

‡ Archiv. f. Microscop. Anat., 1869, V.

CIRCULATION.

THERE are as yet many contradictory views regarding the circulatory system. Delle-Chiaje, who was the first to describe the circulation of the Echini, entertained somewhat erroneous views; the subsequent observations of Tiedemann have in the main been confirmed by Agassiz, Valentin, and Müller. In the Desmosticha we have a genital ring surrounding the anal extremity of the alimentary canal, which sends out, near the madreporic body, a branch leading towards the jaws, following the course of the stone canal and opening into the heart (an ovoid canal), from the base of which it emerges again to form a circular ring round the œsophagus, and then follows the inner edge of the alimentary canal as the alimentary artery, while on the outer edge of the alimentary canal runs what we might call the alimentary vein, connected with the heart, sending out branches to the test and to the walls of the alimentary canal. No vibratile cilia have been detected in the circulatory system. In addition there is, according to Valentin, a branch of both these systems extending along the ambulacral tubes, but I have been unable to trace it. The heart is an ovoid canal surrounded by a vibrating membrane, a sort of pericardium.

The same general course of the circulatory system is traced in the Clypeastroids; we find the inner and outer vessel following the course of the alimentary canal (*Pl. XXXVII. f. 1; Pl. XXIX. lower fig.*), with a well-developed œsophagal and genital circular ring (*Pl. XXIX.*).

In the Petalosticha, the circulatory system does not follow as intimately the course of the alimentary canal, but is carried partly upon the mesenteric plates connecting the windings of the alimentary canal (*Pl. XXXII. f. 17, 18*). Hoffmann has succeeded in proving for Spatangoids the existence of a connection between the water system and the circulatory system (*Pl. XXXII. f. 17*), which had formerly been shown, by Agassiz, to exist in Echinarachnius. This connection has not as yet been traced in Desmosticha, though it undoubtedly does exist also, as blood cells have been found in the water system. The course of the actinal vessel on the actinal floor, with a branch leading along the anal extremity of the alimentary canal, as well as its

connecting branch leading to the circular ring of the water system, is well shown in Echinarachnius (*Pl. XXXI. f. 2*). No heart has been found in Spatangoids proper. In Clypeastroids we have what we may perhaps consider a heart, — an expansion of the vessel running along the inner side of the œsophagus.

WATER SYSTEM.

Agassiz first gave an accurate account of the water system of Echinoderms. His discovery of the stone canal, and its connection with the circular actinal water ring and with the ambulacral canals, as well as his subsequent discovery of the connection of this system with the circulatory system, have laid the foundation of the present knowledge of the water system.

The stone canal, starting from the madreporic body, runs along the heart to the circular ring. Its abactinal extremity is protected by a funnel-like prolongation of the madreporic genital plate, which is very prominent in all Petalosticha (*Pl. XIV*[a]. *f. 1–3, 7; Pl. XV. f. 10; Pl. XXXII. f. 12; Pl. XXXIV. f. 1, 3*), though also present in the Desmosticha and Clypeastroids, but not usually so fully developed (*Pl. XXVII. f. 2*). The circular actinal ring surrounds the œsophagus close to the lantern in the Desmosticha and Clypeastroids; with this are connected the five Polian vesicles, and from it also branch the five main radiating ambulacral tubes, which in the Desmosticha and Clypeastroids run towards the auricles, pass through them, and extend along the median ambulacral line to the abactinal pole. These tubes are quite large near the circular actinal ring, gradually diminishing in size towards the abactinal pole (*Pl. XXX. lower fig.*). There are no Polian vesicles in either the Clypeastroids or the Petalosticha, and in the latter the circular actinal pentagon runs immediately round the actinostome, close to the level of the actinal floor (*Pl. XXXII. f. 5, 11; Pl. XXXIII. f. 1; Pl. XXXIV. f. 2, 4*).

From the main central ambulacral tube, which is lined with vibratile cilia, branches are sent off at right angles, on both sides; one branch to each pair of pores, each branch forming a vesicle for each pore, and the two vesicles connecting with a single exterior ambulacral tentacle. These tentacles are expanded by the contraction of the vesicles, and when drawn in the vesicles are fully expanded. In the Desmosticha we distinguish usually the shaft and the sucking-disk (*Pl. X. f. 5, 6*). The shaft is provided with longitudinal muscles, and is strengthened by numerous spicules; at the base of the sucking-disk the spicules form a regular calcareous ring surmounted by polygonal plates, forming the so-called rosette. This rosette is very

variable, according to the size of the individuals examined. The tentacles of the Desmosticha are capable of great expansion and contraction, reaching far beyond the spines (*Pl. V. f. 1–3; Pl. X. f. 1*). All the tentacles do not terminate in a sucking-disk, as in the Diadematidae and the Arbaciadae for instance, where the abactinal tentacles are pointed, and where we find neither terminal calcareous ring nor rosette (*Pl. IV. f. 6*[a]; *Pl. IV. f. 8; Pl. V. f. 1–3, 6–8*). The ambulacral tubes are most sensitive and contract at the least disturbance. In the regular Echini the suckers of the actinal side, which are by far the most powerful, are the main organs of locomotion, and are capable of adhering with considerable force to the surface of the rocks. They are, however, by no means the only organs of locomotion, as I have already shown when speaking of the habits of Arbacia, in which the spines are also used for locomotion on level surfaces, though of course the suckers alone are used when the sea-urchin climbs steep slopes, to which it can cling very firmly by the suction of the ambulacral tubes,— so firmly that considerable force is necessary to separate a sea-urchin from a surface to which it has become attached.

In all the regular Echini, except the Cidaridae and some of the Echinothuriae, the ambulacral feet do not extend over the whole of the buccal membrane. We only find near the actinostome five pairs of large buccal tentacles provided with suckers; they are not always circular, but frequently lobed as in Arbacia. In the Cidaridae the imbricated plates, first noticed by Desmoulins in the continuation of the ambulacral system, are pierced for suckers identical with those of the rest of the ambulacral zone, extending unbroken to the actinostome as far as the buccal tentacles, which are not different in size from the other ambulacral tentacles. In all Desmosticha, except the Cidaridae and Echinothuriae, the so-called gills protrude through cuts, more or less deep, in the actinal edge of the coronal plates, between the coronal plates and the buccal membrane. In the Cidaridae these gills are found in cuts of the buccal membrane itself, close to the actinostome. (Müller denies their existence, yet he has himself figured the cuts through which the gills pass in a species of Cidaris.)

In the Clypeastroids the ambulacral tubes are already more complicated and quite different in the so-called petals from those of the rest of the ambulacral system. We find below the petals ambulacral suckers, having much the same structure as those of the Desmosticha, capable of considerable expansion and contraction, with very well developed sucking-disks (*Pl. XV. f.*

2, 3; Pl. XXXI. f. 3); while the tentacles which are found near the actinostome are simple conical water tubes (*Pl. XXXI. f. 14, 15*), resembling the water tubes which are found both in the ambulacral and interambulacral spaces (*Pl. XXXI. f. 10, 11*); they are connected with the ambulacral system by long branches sent off from the main ambulacral tubes at right angles to it (*Pl. XI^f. f. 25*), or scattered more irregularly over the abactinal side of the test (*Pl. XI^f. f. 16*). These water tubes are usually confined to regular lines on the actinal side, forming ambulacral furrows, which may be either simple grooves, as in Clypeaster (*Pl. XI^e. f. 1*) and Laganum (*Pl. XIII^e. f. 7, 9*), or may, as in Scutellidae and Encopidae (*Pl. XII^c. f. 2, 4; Pl. XIII^d. f. 6*), branch from the ambulacral over to the interambulacral space, and sometimes extend, in Dendraster, almost to the abactinal system on the abactinal side of the test (*Pl. XIII^a. f. 3, 4*).

In the Clypeastroids we find modifications of the ambulacral regions which are very characteristic of the suborder: the so-called ambulacral fields covered by minute pores, which exist in their simplest form in Echinocyamus, Fibularia and Echinanthus; these pores carry minute locomotive tentacles, provided with suckers, strengthened by a calcareous ring or rod; they extend laterally in the ambulacral plates. In Clypeaster the minute pores are most numerous along certain lines forming the central part of the ambulacral zone, where they are closely crowded together without any apparent order; the smaller pores which carry the sucker-bearing tentacles do not extend on the actinal side beyond the periphery. In another group the furrows are either simple and straight, or fork at a short distance from the actinostome, — the principal forks ramifying again more or less towards the periphery; these ramifications extend in several genera even into the interambulacral spaces, — and it is in the lines of these furrows alone that the minute ambulacral suckers are confined; while in the Clypeastroids, in which the pores extend over the surface of the ambulacral plates, they are arranged either in regular horizontal rows parallel to the suture of the plates, or without any apparent order. When seen from the inner side we find in one section of the Clypeastroids that there are calcareous needles running between these ambulacral pores; in the other section these needles are united to form a double floor extending over the whole inner surface of the test, except over the petaloid part of the ambulacral zones, which is only covered by small needles separating the rows of double pores. This dædalus of poriferous channels extends over the whole of the ambulacral

and interambulacral systems, except the abactinal part of the latter which lies between the petaloid ambulacra. Müller has made a calculation that in an Echinanthus rosaceus of ordinary size there must be as many as 100,000 locomotive pores; they have been figured in a young specimen on *Pl. XI^f.* The ambulacral galleries are readily seen on the inner side of Clypeaster subdepressus (*Pl. XI^b. f. 4*), Echinanthus rosaceus (*Pl. XI^c. f. 2*), in Mellita (*Pl. XII^a. f. 1–3*), and in Encope (*Pl. XII^b. f. 1; Pl. XII^c. f. 4*). Connected with the ambulacral system of the Clypeastroids is the forked prolongation of the actinal ambulacral edge of the test forming a tube with several openings, which give passage to small tentacles identical with those of the furrows proper. Agassiz considered them as the probable openings of gill passages, but neither Müller nor myself have been able to find in living Echinarachnius anything but the tentacles mentioned above.

The course of the water-system branches is well shown in Echinanthus (*Pl. XI^c. f. 2*), and in Mellita (*Pl. XII^a. f. 2*), seen from the actinal side; when seen from the interior, the branches of the water system on the actinal floor are shown in *Pl. XXX. lower fig.* Although the tentacles of the petaloid portion of the ambulacral zone are apparently so different, they are in reality only modified sucking-tentacles; in the earliest stages of some of the Spatangoids and Clypeastroids examined, no difference exists, previous to the formation of the petals, between the tentacles of the abactinal and actinal part of the poriferous zones.

Echinarachnius is interesting as showing, even in the oldest specimens examined, traces of a sucking-disk together with a great development of the base of the tentacle, which characterizes the so-called abactinal gills of the Clypeastroids and Spatangoids. The young tentacles are at first all provided with sucking-disks (but without a terminal rosette); as fast as the petals commence to form, by the spreading of the abactinal part of the poriferous zones, the pores not yet becoming conjugated, the tentacles assume a conical shape (*Pl. XXXI. f. 6*); with advancing age the tips elongate (*Pl. XXXI. f. 4*), and finally are capable of considerable expansion and contraction independently of the flat basal part of the tentacle (*Pl. XXXI. f. 5, 7–9*). During this growth the terminal portion has constantly been thickening, assuming more or less the appearance of a sucking-disk (*Pl. XXXI. f. 12*). As in the Desmosticha and in all Echini, no matter how widely separated the conjugated pores of the petaloid portion of the ambulacra may be, the flattened base of the suckers forms but a single tentacle (*Pl. XXXI. f. 13*), with two

canals, one leading to each ambulacral pore. In the Echinanthidae the ambulacral tubes of the petaloid part of the ambulacra are fringed, and probably perform the function of gills (*Pl. XI^f. f. 17, 18*). In a young specimen of Echinanthus the abactinal tentacles could not be distinguished from those of the margin of the test; they were provided with disks, and capable of considerable expansion and contraction even after the first appearance of the petals (*Pl. XI^f. f. 4*).

In the Petalosticha we find extensive differences in the character of the ambulacral tubes. In the Echinonidae the suckers do not differ from those of the regular Echini; they are, like them, provided with powerful sucking-disks, from the actinostome to the abactinal system (*Pl. XIV. f. 2*). In the Cassidulidae there are three kinds of ambulacral tubes: the tubes of the phyllodes with lamellar extremities as in Rhynchopygus (*Pl. XXXII. f. 8–10*); simple ambulacral tubes, with a slight thickening of the extremity, forming more or less rudimentary suckers,—the suckers are well developed in Echinolampas (*Pl. XVI. f. 13*); they extend from the phyllodes to the base of the petals;—and lastly, the tubes of the petals, which are flat, broad tubes slightly lobed laterally and at the end (*Pl. XXXII. f. 6, 7*); the tubes of all the petals are identical; the odd anterior ambulacrum does not differ in structure from the others, the abactinal part of this ambulacrum forming a regular petal, like the lateral ambulacra (*Pl. XXXIII. f. 2*; *Pl. XV. f. 2, 4, 5*; *Pl XV^a. f. 1, 5*). Each one of the tubes of the petals extends, as in Echinarachnius, from the inner pore of the petals to the outer one.

In the Spatangoids proper we have a still greater variety of ambulacral tubes, owing to the difference in structure of the odd anterior ambulacrum. This is never petaloid in the ordinary sense of the word (*Pl. XXIII. f. 3*; *Pl. XXXIII. f. 7*; *Pl. XXXIV. f. 1, 3*; *Pl. XXI^c. f. 9*);—see also the figures of Spatangoids seen from the abactinal side (*Pl. XIX^a.*; *Pl. XIX^b.*; *Pl. XIX^c.*; *Pl. XXI^a.*; *Pl. XXIII^a.*),—the ambulacral tubes of the anterior ambulacrum are usually short, thick, stout tubes, with large terminal suckers (*Pl. XIX. f. 1, 2*), or pointed extremities (*Pl. XVIII. f. 9, 19*). The buccal tentacles immediately round the actinostome terminate in club-shaped appendages (*Pl. XVII. f. 16*; *Pl. XXXII. f. 16*). They occupy the figures formed by the pores corresponding to the phyllodes of the Cassidulidae (*Pl. XXII. f. 4*; *Pl. XXI. f. 4*; *Pl. XXIII. f. 4*) (see also figures of Spatangoids seen from the actinal side in *Pl. XIX^a.*; *Pl. XIX^b.*; *Pl. XIX^c.*; *Pl. XXI^a.*; *Pl. XXIII^a.*) which are not as complicated as in the Cassiduloids,

owing to the absence of bourrelets. The radiating ambulacral tubes send to the pores forming the phyllodes much larger branches than to the pores of the remainder of the ambulacral system (*Pl. XXIII. f. 1; Pl. XXXIII. f. 1; Pl. XXXIV. f. 4*).

In the odd anterior ambulacrum the ambulacral tubes consist entirely of so-called locomotive tentacles, that is, tentacles slightly rounded at the tip without any prominent sucking-disk; when there is a peripetalous fasciole present, we find, within the peripetalous fasciole, that the tentacles of the upper part of the odd anterior ambulacrum are usually larger than those nearer the ambitus, and that they are provided with a powerful indented or scalloped sucking-disk, strengthened by radiating spokes extending to the periphery. Whenever we find a subanal fasciole present, tentacles like those near the actinostome protrude through the large pores of the field. The Echinonidae are the only Petalosticha having ambulacral feet provided with suckers extending from the buccal membrane to the abactinal pole. They do not, however, extend on the buccal membrane itself; that seems to be a feature eminently characteristic of Desmosticha, and is not found in any of the Clypeastroids or Petalosticha thus far known.

The tentacles between the phyllodes and the petals are usually simple tubes, either pointed at the extremity or with rudimentary sucking-disks (*Pl. XVII. f. 16*). The tubes of the petals are lobed laterally as in the petaloid ambulacra of Clypeaster. In the Petalosticha the tentacles are not the only organs of locomotion. These, except the tentacles of the phyllodes, are, as is well known, too delicate to play more than a very secondary part in locomotion, so that in Spatangoids the spines of the actinal side must be used to a considerable extent. In all Spatangoids the power of locomotion is quite limited; the spathiform and spoon-shaped spines of the actinal plastron, usually so much stouter and more powerful than those of the rest of the test, are their main organs of locomotion.

Another important structural distinction between the Clypeastroids and the Spatangoids is found in the ambulacral system. In Spatangoids proper the ambulacral plates of the abactinal part of the test alone are perforated by two pairs of pores, while toward the ambitus and on the actinal surface, where the ambulacral plates increase in size, they are pierced by a single opening; this, as I have already shown in Echinolampas, is due to the extension of one zone of the poriferous system towards the actinostome, while the other extends no farther than the petals, or but little beyond them. In the

immediate vicinity of the actinostome the plates become smaller again, the ambulacral pores increase in distance to form the buccal rosette, which has received the name of phyllode from Desor, and was supposed to be eminently characteristic of the Cassiduloids alone, but which evidently is also found in the Spatangoids proper. In the Clypeastroids the innumerable ambulacral pores, found both in the horizontal sutures above the ambitus and in the ambulacal furrows of the actinal side, often extending into the interambulacral spaces, give the ambulacral system a widely different structure from that of the Spatangoids. The buccal rosette is limited to its simplest expression in Echinarachnius; *Pl. XXXI. f. 14, 15*, shows the simple terminal tentacles immediately adjoining the actinostome.

In the Spatangoids the buccal tentacles have usually been considered as gills; but from what Mr. Robertson has shown in the case of Echinocardium, they are evidently to be considered as organs of locomotion and prehension, and seem, in spite of their apparent delicacy of structure, capable of exerting considerable power in digging into the ground and enabling the helpless Spatangoids to fill their alimentary canal with the fine sand from which they derive their main supply of food. To assist them in this operation the actinal membrane is found to be quite movable, capable of considerable expansion far beyond the line of the lips of the actinostome proper. The buccal tentacles terminate at the extremity in a cluster of irregularly arranged club-shaped appendages, strengthened internally by limestone rods (*Pl. XXXII. f. 16*). This is a totally different structure from that of the so-called gills of the regular Echini (compare *Pl. V. f. 5*, where I have figured the branching gills of Arbacia). These grape-like gills are not connected with the circular canal but with the interior cavity; they are therefore filled by the introduction of water through the edge of the madreporic body. Similar gills are found in all Desmosticha, although Müller denies their presence in Cidaridae; even there they are found, but close to the jaws. The buccal tentacles of the Spatangoids and Clypeastroids are the homologue of the ten large buccal tentacles (*Pl. V. f. 4*), placed immediately around the mouth in the regular Echini, and which pierce the ten large prominent actinal plates found on the actinal membrane of all Desmosticha, whether that membrane be regularly imbricated or not.

In the Clypeastroids proper we have seen that these buccal tentacles differ in no wise from the adjoining ones of the ambulacral system, and in some Spatangoids (Rhynchopygus) the buccal tentacles are much simpler (*Pl.*

XXXII. f. 8–10), though protruding from pores which have the regular arrangement of phyllodes (*Pl. XV. f. 1, 3; Pl. XV^a. f. 2; Pl. XXXII. f. 5; Pl. XXXIII. f. 1*). Hoffmann has already called attention to the absence of gills in Spatangoids; he correctly suggests the presence of gills proper in Cidaridae, although this had been denied by Müller. The cuts for their passage are found, as I have already stated, not in the test, as in the regular Echini (see *Pl. VII. f. 20*), but near the actinostome in the actinal membrane; so that their position is quite different in the Cidaridae (*Pl. I^f. 6; Pl. II^b. f. 2, 3; Pl. II^c. f. 11*), and in the other regular Echini (*Pl. I^g. f. 6; Pl. III^c. f. 2*).

In the Desmosticha the ambulacral suckers, as is well known from the early descriptions of Valentin and the subsequent memoirs of Stewart, are strengthened by limestone plates (the disk) in the termination of the sucker itself; the disk formed in the sucker consists of four terminal pentagonal plates (*Pl. XXXVIII.*), the outer edge of which is more or less indented, but the form of the marginal indentation does not enable us to recognize with tolerable certainty the genus to which these disks belong, as the indentations of the margin are but so many points of growth which, with the increase of the plate, become part of the interior of the disk, and at different stages present a very varied outline. These disks are riddled with holes, formed by the component limestone rods. Immediately under the terminal disk four smaller plates are placed, and they form a gradual passage, as far as I have been able to observe them in the Diadematidae and Cidaridae, to the more simple ambulacral calcareous spicules found along the shaft of the tube (*Pl. XXXVIII.*). The lower spicules appear to be arranged without any special order, they are placed near the periphery of the ambulacral tube, and are evidently of use in strengthening the thin walls of the tentacles. In the Petalosticha (*Pl. XXXVIII. f. 24, 25, 27*), the spicules in the terminal part of the actinal tentacles of the phyllodes pass gradually into the irregular spicules of the shaft of the tube. The terminal spicules differ in no way from those of the shaft, as there is no regular disk composed of plates, but the thickened base of the long spicules (*Pl. XXXVIII. f. 24–26*) is undoubtedly homologous to the plates of the sucking-disk of Desmosticha. In Echinonëus (*Pl. XXXVIII. f. 26*) I have only seen the spicules of the shaft, they remind us somewhat of the shorter spicules of the Petalosticha; there are no regular terminal plates as in the Desmosticha, although the terminal sucking-disks are well developed in the ambulacral tubes of Echinonëus.

When taken in connection with other structural features, the general aspect of the plates and spicules of the ambulacral tubes may be of some value in tracing the affinities of genera; but the mode of formation of all the calcareous deposits of Echinoderms, as large open limestone cells, is subject to such remarkable variations in the same species, that characters drawn from the spicules of the ambulacral tubes of the ovaries and of the alimentary canal must be used with great caution, as the merest inspection of the figures of the terminal plates of a few of the leading genera will readily show (*Pl. XXXVIII.*). The variations are still more striking if we compare the spicules from the shafts of the tubes (*Pl. XXXVIII. f. 4–6, 7–9, 16, 17, 30, 31, 34, 35*) of a few of the species figured. The same extreme variations occur in the spicules from the ovaries and from the alimentary canal of the same species (*Pl. XXXVIII. f.* 2^{a-c}, $14^{a, b}$, 12^{a-h}). Valentin, and subsequently Stewart and Herepath, have called attention to the systematic value of the spicules. An additional number of spicules from the ambulacral tubes have been figured by Perrier in his Memoir on the Pedicellariæ, and the probable passage of the terminal disk of the Desmosticha into the spicules of the shaft of the tube intimated for one family (the Diadematidae). He has also, as Müller had previously shown so well, called attention, as a new feature, to the absence of a terminal calcareous disk in Petalosticha.

In the Desmosticha the ambulacral pores pierce the ambulacral plates; the same is the case also in the Clypeastroids and Petalosticha, only in the petaloid portion of the ambulacra they are placed in the sutures between adjoining plates, and towards the extremity of the petals the pores gradually pass from the sutures to the central part of the plates. In the Desmosticha and Petalosticha we never find more than one double pore for each ambulacral plate; this is by no means the case in the Clypeastroids, in which, as was first shown by Müller, the number of ambulacral pores increases with age as fast as the ambulacral plate increases in size. The phyllodes of the Cassidulidae form no exception to this rule among the Petalosticha, for Müller has plainly pointed out that it is owing to the unequal development of the ambulacral plates, — two small ones and a large one alternating, — that the phyllodes are developed. It is the connection of the primordial ambulacral plates in series of three or more plates (secondary ambulacral plates, but originally all of the same value), which has served to a greater or less extent to distinguish genera among the Desmosticha. See analysis of the plates of the ambulacral system (*Pl. VI.*). Among the Clypeastroids and

Spatangoids the sutures of the plates, both in the ambulacral and interambulacral system, are always readily traced, while in the Desmosticha the sutures of the ambulacral system, frequently become obliterated, and can only be traced with difficulty; when seen from the inner side of the test, the sutures are often still apparent when they can no longer be traced from the outer side of the test. In the Desmosticha the new plates are formed between the apical system and the upper part of the ambulacral system;* the position in which additional pores are found, one on each side of the odd terminal tentacle, corresponds to the mode of addition of new suckers traced in the starfish.† The same is the case in the Clypeastroids, as has been shown by Philippi and Müller; but, as I have shown in the examination of the young Echini from the Report of the Deep Sea Echini of Florida, the growth of the ambulacral and interambulacral systems takes place independently, — the ambulacral plates increase very rapidly in number, while the coronal plates increase slowly in number, but gain in breadth and in height. This is especially the case with the ambulacral plates of the Clypeastroids, in which they assume such an immense preponderance over the interambulacral plates, which in many genera are quite narrow belts on the lower surface.

The buccal imbricated plates of the actinal membrane also increase independently of the coronal plates. The new plates are added next to the fixed actinal edge of the coronal plates, as fast as the opening of the actinal system increases in size; the edge of the coronal plates is denoted by the position of the auricles which arise from the outer oral edge of the coronal plates. This is especially well seen in the mode of growth of the buccal plates in Cidaris, as first shown by Müller. An apparently very important modification of this mode of growth is found in the buccal system of Asthenosoma; when seen from the outer actinal side the plates of the actinal system seem to be firmly soldered with the coronal plates, as if no new plates were intercalated between the coronal plates and those of the buccal membrane. Such, however, is not found to be the case; when the junction of the coronal and buccal plates is examined from the inner part of the test, we find small new plates which gradually force their way between the two systems below the thin slight auricles found upon the outer edge of the coronal plates proper, as in other Echini.

* First shown by Agassiz, and subsequently confirmed by Philippi and Müller.

† See A. Agassiz's Embryology of the Starfish, 1864.

In the Clypeastroids we have at an early age a fixed equatorial periphery. The plates which compose the actinal side of the test at an early age attain the number which they reach in the largest specimens, and then increase only in length and breadth, while in the upper part of the test the plates do not increase as rapidly, and small new plates are added to the test at its apical portion. The distinction established by Müller between the (Cidaridae) Desmosticha and Clypeastridae, based upon the permanence of the periphery (edge of the test), is valid only after a certain stage of growth, and does not hold good in the very youngest stages of some of the Clypeastroids I have had occasion to examine (Echinarachnius, Mellita, Clypeaster). Additional plates are also added at the apical pole of the Petalosticha. In Spatangoids proper we have a still smaller number of interambulacral coronal plates than in the Clypeastroids; additional plates are only added in the ambulacral regions, the interambulacral plates keeping pace with the growth of the ambulacral zone by their increase on the edge of the coronal plates.

The ambulacral suckers in the case of the Desmosticha and Clypeastroids ride upon double pores; on the abactinal part of the test of the Spatangoids below the petals the pores gradually approach and finally frequently coalesce, forming a single opening. In the Clypeastroids we have, in addition to the large suckers of the ambulacral system, transverse rows of single minute pores also belonging to the ambulacral system, piercing the plates of the ambulacral system near the sutures. These pores were first traced by Agassiz in Echinarachnius, and shown by him to be connected with the ambulacral system by direct injection. They increase (laterally) in number with the age of the test, as can readily be seen when comparing Clypeastroids of different sizes.

The coronal plates of the Desmosticha are made up, near the actinal system, of an equal number of zones of ambulacral and interambulacral plates; while round the actinostome of the Clypeastroids the so-called buccal rosette is formed, which consists entirely of ambulacral plates touching one another, the interambulacral plates commencing only as a single plate on the second and sometimes even only on the third row from the actinostome.

MADREPORIC BODY.

The function of the madreporic body is to introduce water into the water system through the stone canal. The madreporic body occupies, however, a larger space than the termination of the stone canal, so that a large portion of the pores lead directly into the cavity of the body, and through its openings currents can flow in or out. The water is either forced in or out according to the greater or smaller space occupied by the ovaries at different times, by the filling or emptying of the alimentary canal, by the expansion or contraction of the ambulacral vesicles, all these conditions change the state of equilibrium and produce currents of water either inward or outward through the madreporic body. In the Desmosticha and Clypeastroids, where we have an actinal membrane of considerable size, the power of increasing the capacity of the interior of the test is very marked. We frequently find our common sea-urchins (Toxopneustes, Strongylocentrotus, Diadema, Hipponoë), when alive, with actinal membranes distended to an extraordinary degree, projecting far beyond the general level of the actinostome. It is probable that there also exists a connection between the water system, the circulatory system, and the perivisceral cavity of the test; but, however probable this connection may be from some of the phenomena observed (the presence of pigment cells in the water of the interior), the actual connection is not yet proved. Hoffmann has made similar observations, but has not been able to trace the direct communication. I have seen spermatozoa escape through the madreporic body of our common sea-egg (S. Dröbachiensis), and this appears the only way they can escape when, through accident or otherwise, they fall into the interior cavity by the breaking of the walls of the spermatic sacs.

The madreporic body, as has been stated before, occupies a part of one of the genital plates; it is entirely within the genital ring in the Desmosticha. It is disconnected from the genital plates in many of the Clypeastroids, occupying the central part of the apical system, and it is connected with the right anterior genital plates in the Petalosticha, while at the same time it fills a greater or less space of the intergenital apical system.

NERVOUS SYSTEM.

THE nervous system of Echini has been shown by Tiedemann to consist of a circular ring with five ambulacral branches. The circular ring surrounds the œsophagus. It is placed above the actinostome and the extremity of the pyramids in the toothed Echini; in the Petalosticha it is placed round the actinostome at the point of contact of the upper lip and of the test, where it forms an irregular pentagon, from the angles of which the five ambulacral branches radiate. This is the general structure in all Echini. The nervous ring is intimately connected with the circular aquiferous ring placed within the nervous pentagon. The ambulacral canals cover the nervous branches, passing over the nervous pentagon at their origin.

Krohn* was the first to observe accurately the course of the nervous system. The pentagon is kept in its place by delicate transverse bands. The ambulacral branches are somewhat broader than the pentagonal ring, and send off delicate lateral branches, in its course towards the anus (*Pl. XXXI. f. 18*), which extend under the ambulacral vesicles. According to Müller, branches are sent to the pedicellariæ and to the muscular base of the spines.

* Archiv. f. Anat., 1841.

HABITS OF ECHINI.

Many of the Desmosticha, along coasts exposed to the action of the waves, live in cavities which they hollow out of the solid rock. This they do, not by means of any solvent, but by mere mechanical action. They chisel out with their teeth the solid rock by incessant turning round and round, and keep their cave, where they are frequently prisoners for the rest of their existence, up to the size required by the growth of their test and spines by constant gnawing. Along parts of the coast of France, Strongylocentrotus lividus excavates in the solid granite. Caillaud has given an account of their abodes. From the Azores the Museum possesses the same species, occurring in cavities dug out of the solid rock. On the coast of California the common Strongylocentrotus purpuratus occurs in the same way; we find long tracts of the shore, where this sea-urchin is common, completely honeycombed and pitted by cavities and depressions, in which they seek shelter against the powerful surf continually beating against the rocks. The same species does not excavate in sheltered places, where the sea-urchins can find protection between the interstices of large fragments of rock, or ledges more or less sheltered from the more direct action of the open sea. Stimpson says that Colobocentrotus is found at the Bonin Islands adhering, simply by their suckers, to the perpendicular faces of rocks exposed to the full fury of a Pacific Ocean swell. We must remember that the test of this genus forms with its spines a flat segment of a sphere, and that the close pavement of polygonal spines presents but little surface to the action of the water. The suckers of the actinal side are also very powerful and numerous. Some of the species of Echinometra have the same habit of excavating a recess, in which they grow. Echinometra Van Brunti is quite common at Panama in cavities formed by the sea-urchin in the solid rock of the reef running out from the town. Cidaris Thouarsii is also found in similar cavities in the same locality. On the Florida reef, our common West India Cidaris has sometimes the same habit of hollowing out a cave for protection, where greatly exposed, though it is quite as frequently found free in the spaces between masses of rock.

The Clypeastroids are mainly found in sand, considerably below low-water mark, though some of the species seem to thrive on the edge of that line, where they are exposed to the full force of the surf on open sandy beaches. Echinarachnius parma, Echinarachnius excentricus, Mellita testudinata, and Mellita longifissa are quite common in certain localities at low-water mark, where the force of the breakers is very considerable. As a general rule, however, the Clypeastroids, as well as Spatangoids, prefer quiet sandy bottoms, in which they bury themselves. All the Echini, as far as known, are more or less gregarious; those who have had occasion to collect on our rocky shores cannot fail to have noticed how sea-urchins are frequently crowded, in favorable localities, over the surface of the rocks, so as literally to pave the bottom of sheltered rocky pools. Professor Verrill has also brought up from deep water our common sea-urchin in large numbers at a single haul of the dredge. The same is the case with our more southern species. Echinarachnius, Encope, Mellita, Echinanthus, are all gregarious. The few Spatangoids I have had occasion to observe alive — Meoma, Moira, Echinocardium, Rhynchopygus — are all found in numbers. As has been observed by Thomson and Jeffreys, in some localities, in deep water the dredge has come up filled with thousands of specimens of Echinus. Cidaris, though not very numerous along the shores and in shallow water, appears in deeper water to be gregarious, as large numbers of Dorocidaris have been brought up at a single haul of the dredge by Mr. Pourtalès from considerable depths. No dredging can be done on sandy bottoms along points of our coast without bringing up large quantities of Echinarachnius.

The same has been Stimpson's experience in the China Seas with Echinarachinus mirabilis, which frequently covers the bottom of the sea for considerable distances. Colobocentrotus, he also says, occurs in great numbers. A coral reef literally bristles with Diadematidae, and cavities in the more sheltered spots are filled with them. The Echini serve as food for fishes with sufficiently powerful jaws. Our cod and haddock are great eaters of the two more common species of sea-urchins of New England.

EMBRYOLOGY.

THE embryos of our common sea-urchin * resemble most closely, in some of their earlier stages, those of Strongylocentrotus lividus, figured by Müller on Plates VI. and VII. of his fourth Memoir.† The figures which Müller gives correspond with what I have observed in larvæ obtained by artificial fecundation. He succeeded in tracing them for about three weeks, which is not quite as long as I have kept them alive. Müller has unfortunately not given us any figures of the very first stages of this species, nor has he found the adult larvæ swimming about immediately before the resorption of the pluteus. The series of figures found in the Memoirs of the American Academy,‡ and here reproduced, will give us a more complete idea of the different phases of growth of one species of Echinus than can be gathered from a comparison of the different species which Müller has investigated. It will enable us to trace the order of appearance of the arms of the pluteus, and the last changes which the larva undergoes immediately before the young sea-urchin has resorbed the whole framework of the pluteus.

The progress of segmentation of the yolk is entirely similar to what we observe in the starfish; the main differences in the eggs are simply of proportion between the relative size of the yolk-mass and the outer envelope. My observations agree with the account of the segmentation given by Derbès.§

In addition to the striking difference in color noticed between the spermaries and ovaries at the time of breeding (the latter are yellowish-orange, while the former are milky-white), we find external differences at that period which enable us readily to distinguish the males and females by the more vivid coloring of the spines of the latter, which are of a violet tinge, while those of the males are more yellowish-green.

The earlier stages of development here described were raised from eggs artificially fecundated, while the older pluteus stages were found nomadic,

* Strongylocentrotus Dröbachiensis.

† MÜLLER, J., Ueber die Larven und die Metamorphose der Echinodermen. Vierte Abhandlung. Berlin, 1842.

‡ AGASSIZ, ALEX., Embryology of Echinoderms, Mem. Am. Academy, IX. 1864.

§ DERBÈS, Ann. d. Scien. Nat. 3e Serie. VIII. p. 80. 1847.

floating on the surface, but in sufficiently early stages to connect them with the stages raised by artificial fecundation.

In the common sea-urchin of our New England coast (S. Dröbachiensis) the genital organs become mature during the winter, February usually being the month during which artificial fecundation has ordinarily succeeded. The eggs and spermaries at that time fill the internal cavity to such an extent that the alimentary canal is completely surrounded by the clusters of the genital organs. At the time of spawning the eggs are closely packed, pressed into all sorts of shapes, but when they escape in the water, and are allowed to remain in it a short time, the outer envelope, which appears to consist of a thick homogeneous, structureless shell, swells very materially when the pressure is removed, and becomes perfectly spherical (*Fig. 19*). The spermatic particles, as in the case of the artificial fecundation of the starfish, soon find their way to the outer envelope of the egg to which they attach themselves, beating about very violently the whole time. The spermaries are sometimes so crowded that they form a halo round the outer envelope, as in Asteracanthion. I have not been able to see the spermatic particles reach the surface of the yolk. By the constant beating of the innumerable spermaries the egg is set in rotation. The first change noticed is

Fig. 19.

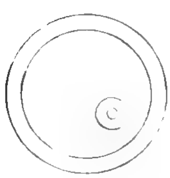


Fig. 20.

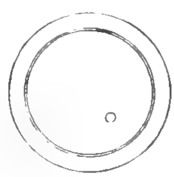


Fig. 21.

Fig. 22.

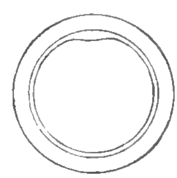
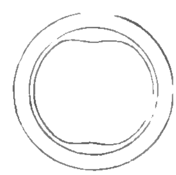


Fig. 23.



the disappearance of the germinative vesicle (*Fig. 20*); soon after this the germinative dot vanishes. The first trace of segmentation consists of a separation of the yolk from the inner wall of the outer envelope (*Fig. 21*); the yolk is then slightly depressed on one side (*Fig. 22*), a similar change soon occurring on the opposite pole (*Fig. 23*).

Segmentation takes place very rapidly, the egg passing in a few hours from the stage of *Fig. 19* to that of *Fig. 30* immediately before the escape of the embryo from the egg. The spheres are well separated, having a centrifugal tendency, and as they increase in number they arrange themselves in a shell-like envelope (*Figs. 28 – 30*), which eventually becomes the wall of the embryo. This centrifugal tendency is already apparent when there are not more than eight spheres, and as early as the stage of *Fig. 28*; when there are

only thirty-two spheres, the envelope is quite prominent. The rotation of the spheres of segmentation commences before this, and is entirely independent of the motion given to the whole egg by the spermatic particles; this stops after the rotation of the spheres of segmentation has commenced.

The Richtungs Bläschen of Schultze were also observed in the segmentation of the yolk of the sea-urchin. They are noticed, before the yolk has been divided into halves, as three or four small granules situated at the extremity of the axis which is to divide the yolk into two portions (*Figs. 21, 24*). They are developed from the yolk itself as a slight swelling, which afterwards becomes entirely distinct from the mass of the yolk, retaining always throughout the process of segmentation the same relative position to the axis of segmentation. The part they play in the subsequent history of the embryo is not known; they only appear at one pole of the first axis of segmentation.

Fig. 24.

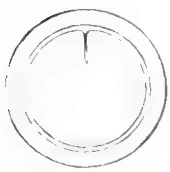


Fig. 25.

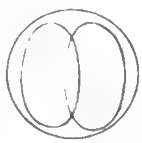


Fig. 26.

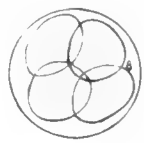


Fig. 27.

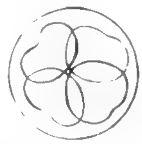


Fig. 28

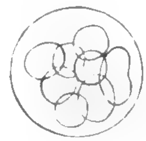


Fig. 29.

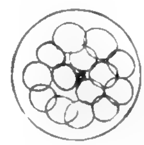


Fig. 30.

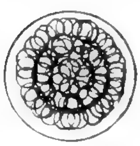


Fig. 31.

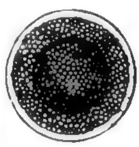


Fig. 32.

Fig. 33.

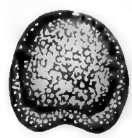


Fig. 34.

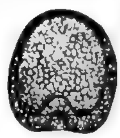


Fig. 35.

After the depression at the poles of the yolk is formed, the segmentation commences (*Fig. 24*); a slit is formed, which soon divides the whole yolk into two large elliptical masses (*Fig. 25*). These again subdivide into four spheres (*Fig. 26*); in the next stage (*Fig. 27*) the four spheres show the first sign of a further subdivision, and in the subsequent stage (*Fig. 28*) there are eight spheres. In the stage of *Fig. 29* the spheres are small, and show a tendency to form a shell, which is very marked in the next stage figured (*Fig. 30*), where the walls of the embryo are very distinct; in *Fig. 31* the segmentation has been carried on till the spheres are very minute and the walls of the embryo most distinct. It is the stage immediately preceding its escape from the egg. In the embryo, when hatched, the walls of one pole at once become thicker (*Fig. 32*). A depression is formed at that extremity; the embyro at the same time becomes elongated; this depression is the first trace of

the first opening formed leading into the stomach (*Fig. 33*). With the formation of the depression a slight flattening also occurs. In the next stage (*Fig. 34*) the thickened wall bends in forming a shallow depression. This depression goes on, becoming deeper (*Fig. 35*) and deeper (*Fig. 36*) until it forms a pouch extending half the length of the embryo (*Fig. 37*); the walls of the pouch retaining their thickness, while the walls of the embryo itself become more and more attenuated at each succeeding stage. Water flows freely into and out of this cavity; currents are established, running in different directions along opposite walls of the pouch, showing this opening for the present to be a mouth, as in the embryo of Asteracanthion, the pouch sustaining the same relation to the whole body as in other Radiates.*

The embryo, on escaping from the egg, resembles a starfish embryo,† and it would greatly puzzle any one to perceive any difference between them. The formation of the stomach, of the œsophagus, of the intestine, and of the water-tubes takes place in exactly the same manner as in the starfish, the

Fig. 36.

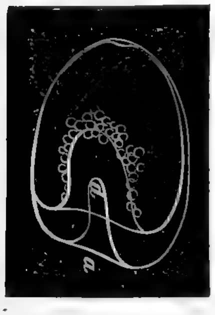


Fig. 37.

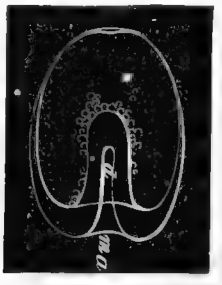
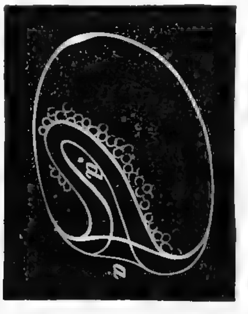


Fig. 38.



time only at which these different organs are differentiated not being the same. We have thus very early in the history of these two orders differences which to a practised eye tell at once to which of them the young embryo belongs. A particularly important difference is the formation in Ophiurans and in Echinoids of calcareous rods at an early period of the pluteus condition.

The small cavity first formed goes on increasing in length until we have a hollow cylinder (d) extending half the length of the embryo, as in *Figs. 36*

* So far the changes which have been observed do not differ materially from what we know of the earlier stages of Echini embryos from Derbès, Müller, and Krohn. The observations of the earlier stages, as given by Krohn and Derbès, supplement each other, and Müller has taken up the subject where they left it But this is the only sea-urchin in which we have a complete series in the development as complete as that of the common starfish of our coast, which I published in 1864.

† See Figs. 4 and 5 of my paper on Asteracanthion, in Proc. Am. Acad., Vol. VI., April 14, 1863, which represent the corresponding stages of the embryo of the starfish, and the figures in Pl. I. and II. of the Embryology of the Starfish.

and *37*. In the profile (*Fig. 36*) we notice the same tendency in the digestive cavity (*d*) to incline towards the lower side, after the dorsal portion has increased more rapidly, giving the anal part of the embryo a bevelled appearance. In a somewhat older stage (*Fig. 38*) the digestive cavity is still longer, and almost touches the lower side. We notice a difference between the starfish and the sea-urchin in the time of formation of the alimentary canal, the stomach, and the œsophagus. In the starfish the mouth is formed before the differentiation of these organs takes place; while in the sea-urchin the mouth is not formed until the alimentary canal and the œsophagus, as well as the water-tubes, are quite distinctly defined (see *Fig. 43*). What is also peculiar to Echini is the presence of large masses of yolk-cells along the sides of the digestive cavity, indicative of the great changes which take place at the points where these masses of yolk-cells are most numerous. We have observed that the yolk-cells are always present wherever any new organ is developed; in these embryos the appearance of the water-tubes is preceded by an accumulation of yolk-masses at the extremity of the digestive cavity (see *Fig. 38*), and the place of the limestone rods (*Fig. 39, r′*) is first seen filled by clusters of yolk-masses, in the midst of which the rods are deposited. Rods extending into the arms are characteristic of Echinoids and Ophiurans; we find nothing of the kind in starfish or Holothurian embryos.

In the next stage (*Fig. 39*) the original cylindrical digestive cavity has already a decided tendency to differentiation, the walls of the stomach (*d*) and of the œsophagus (*o*) being of very different thickness; from *o*, the pouches which are to become the water-tubes (*w*, *w′*) project far beyond the outline of the digestive cavity. The limestone rods (*r′*, *r′*) can faintly be distinguished from the mass of yolk-cells which surround them. The calcareous cells, which take such a great prominence in older embryos (see *Fig. 54*), make their appearance as early as the stage of *Fig. 38*; they are quite large in the condition represented in *Fig. 39*. The marked contrast which already exists between the different parts of the digestive cavity is still more apparent in a stage but slightly more advanced (*Fig. 40*). The dorsal portion of the embryo has up to this time been growing most rapidly, changing the outline of the pluteus, particularly when seen in profile; in the subsequent figures the outline, when seen from above, is also undergoing great changes. The pluteus assumes a more rectangular shape (*Fig. 41*) when seen either from above or from below. The water-tubes are almost separated from the digestive cavity, which has been divided into three very distinct regions (*c*, *d*, *o*,

Fig. 42); the limestone rods, simply T-shaped before (*Fig. 40*), are sending off small processes; and the chords of vibratile cilia (v, v'), which were a simple button (v, *Fig. 40*), are quite stout, projecting beyond the general outline when seen from above or below (*Fig. 41*, v). It is at this advanced condition only that the œsophagus touches the lower surface, previous to the formation of the mouth, which takes place only when the embryo has reached the condition of *Fig. 44*. A view of *Fig. 41*, seen from the anal extremity (*Fig. 42*), shows how far it has lost its cylindrical shape and become wedge-

Fig. 40.

Fig. 41.

shaped. In *Fig. 43*, which is the same pluteus seen in profile, the indentation which indicates the position of the mouth (m) has changed somewhat the even outline of the lower surface; there is a marked bending of the alimentary canal, bringing the anal opening (a) still nearer the lower surface. In fact, since the first formation of an opening in *Fig. 19* (a, m), which is at once strictly mouth and anus, there is a continued tendency in the anal part of the digestive cavity to bend towards the oral surface, even while this single

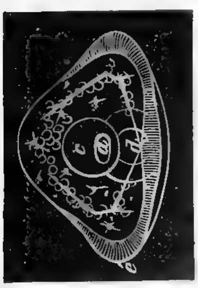


Fig. 43.

opening performs the functions of mouth and anus, during the period which precedes the formation of the mouth, after the alimentary canal, the true stomach, and the œsophagus have been differentiated. This is somewhat

different from what we notice in the starfish embryo, where the mouth is formed before the anus has been much bent from its original position.*

The large accumulations of yolk-masses round the rods r' r' cannot fail to be noticed in the stages just described (*Figs. 41–43*). This contrasts strikingly with the starfish embryos, in which we find nothing of the kind, and where the body of the young embryo is quite remarkable for its great transparency, which only increases with age, while in the Echinus embryos the great accumulation of yolk-masses renders them somewhat opaque even in their early stages; the increase of calcareous cells in somewhat more advanced forms (as *Figs. 52, 54*) makes it more difficult than in the starfish to trace accurately the minute changes which the rods and water-tubes undergo. We now come to conditions (*Figs. 44, 45*) which are sufficiently advanced to enable us, by comparing them with still older forms (such as *Figs. 51, 52, 54.*) to form a correct idea of the mode of transformation from the shape of *Figs. 44, 45*, to the complicated pluteus represented in *Fig. 55*. I merely refer to this comparison

Fig. 45.

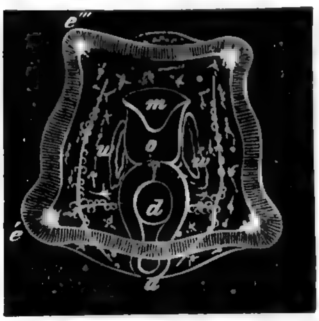


Fig. 46

Fig. 47.

in a general way, as in the explanation of the different stages it will be carried out more fully, to call attention to the periods which first give us a clew to the development of the different parts, by showing us plainly which portions of the embryo must assume a great prominence, and obtain a more rapid development than others, to pass gradually through the stages which are hereafter figured. In *Fig. 44* the difference in the rapidity of the development of the two water-tubes (w, w') is quite striking. The left water-tube (w') — left when seen from the aboral side, the anal extremity being turned down, as in these figures — is fast pushing through the mass of the embryo, and finds its way to the surface at about the condition represented in *Fig. 50*, where the water-pore (the madreporic body) allows the water to enter

* See Fig. 8, Proc. Am. Acad., Vol. VI., quoted above. See Pl. I. and Pl. II., Embryology of Starfish.

freely into this water-tube. In a somewhat more advanced pluteus, seen obliquely from the oral side (*Fig. 45*), we can trace the mode of development of the chord of vibratile cilia; it is formed of a single continuous line, extending round the mouth; it forms but a single shield, and not two, as in the starfish, where the first trace of this chord is the appearance of two separate arcs forming eventually two distinct plastrons. The little pluteus looks in this condition like a quadrangular pyramid with a rounded apex and rounded angles at the base. The corners of the base (e', e''') are the origin of the first arms of the pluteus (*Figs. 44, 45*). Owing to the great increase of the dorsal and oral parts of the embryos, they change their general appearance very rapidly (see *Figs. 46, 47*). As the intestine becomes more distinct from the stomach, the angle which their axes make grows more acute (*Fig. 46*,

Fig. 48.

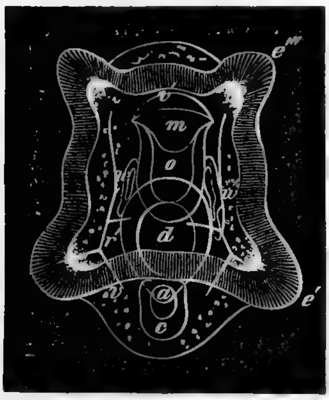


Fig. 49.

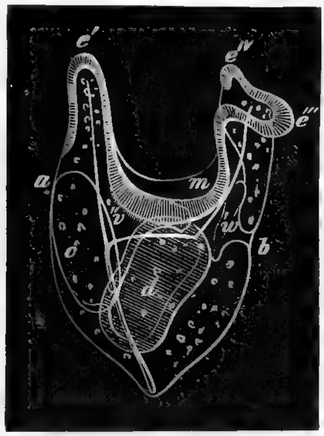
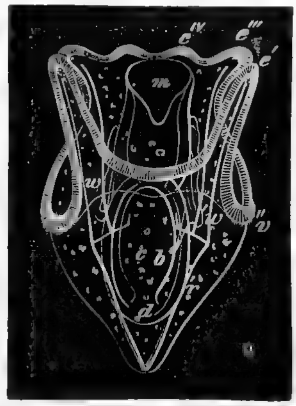


Fig. 50.



c, d); the mouth (*m*) is removed farther from the anus. The walls of the œsophagus (*o*) are now capable of considerable expansion and contraction; they are much thinner than those of the intestine or stomach. *Fig. 47*, which is *Fig. 46* seen from the oral side, shows the course of the vibratile chord, the position of the arms e', e''', the great size of the rods (r') with their branches, and the difference of level between the opening of the mouth and the anus. From an examination of *Figs. 46* and *47* the position of the rods can be determined, one main part extending from the anal extremity to the arms e', another extending in a curved line (*Fig. 46*) from e' to e''', and sending off a small branch which runs between the anus and the digestive cavity (*Fig. 47*). This will perhaps be more clear on examining the pluteus in such a way (*Fig. 48*) as to bring the vibratile chord into the field; this stage does not differ materially from that represented in *Fig. 45*, the changes which have

taken place defining the arms more sharply by the indentations of the vibratile chord. The intestine, the stomach, and the œsophagus are clearly distinguished by the different character of their walls. The water-tubes are not united, and have not increased in size. This condition presents a material difference in the degree of development when compared with the corresponding stage of a starfish (Fig. 11, Proc. Am. Acad.; Pl. I. and II., Emb. Starfish). Here the water-tubes occupy the most important portion of the embryo, while in the sea-urchin pluteus the most striking characteristic is the amount of room taken up by the stomach and œsophagus compared with that occupied by the water-tubes.

In the subsequent stages (*Figs. 49, 50*) the Echinus embryos have reached forms which are already more familiar to us from the drawings of Müller; they resemble closely some of the figures given by him of Strongylocentrotus lividus in his fourth Memoir. A good deal of allowance must be made for the differences of outline between the figures given here and the drawings of Müller. From the evidence of the drawings themselves, it is plain that nearly all the specimens drawn by him are compressed. I have endeavored to represent these embryos as they appear swimming about; it is by no means an easy task to follow them in their almost unceasing movements with the magnifying power required to introduce the necessary details; but I trust I have succeeded in giving a tolerably accurate idea of their appearance in these outline drawings. In an embryo during the tenth day after fecundation (*Fig. 49*), the most important changes are the increase in length of the arms e', e''', and the formation of rudiments of another pair of arms, e^{IV}; the vibratile epaulettes, v'', as Müller has called the peculiar accumulations of vibratile cilia situated between the base of the adjoining arms e', e''', make their appearance at this stage. It is easy to follow them from their origin, when they are simply a thickening of the vibratile chord v'' (*Figs. 49, 50*), until they have passed through the successive stages represented in *Figs. 51, 52, 54,* to attain the great size observed in *Fig. 55,* when they appear in certain positions as having no connection whatever with the vibratile chord, and as having originated independently of the main chord. Müller had not traced their development, and laid great stress on their presence in distinguishing the different species of sea-urchin embryos.

With the development of the arms, the intestine loses its former shape; it has now assumed the appearance of a large elliptical receiver with thin walls. The stomach is somewhat dumb-bell shaped, and the left water-tube

connects with the surrounding water, through the water-pore *b*, which has pushed its way to the surface. The rods keep pace with the growth of the arms (*Fig.* 50); the water-tubes have not increased in size, they are still two distinct bodies. The outline of the anal part of the pluteus is quite pointed; the aboral side is regularly arched, with a slight depression at the point where the water-pore opens (*b*, *Fig.* 49). The opacity of the pluteus has increased to such an extent that it becomes impossible to define clearly the outline of the water-tubes in the stages which come between *Figs.* 49 and 51. I am unable to state positively whether the two water-tubes are united in this and older embryos. All I could distinctly see was the great increase in

FIG. 51.

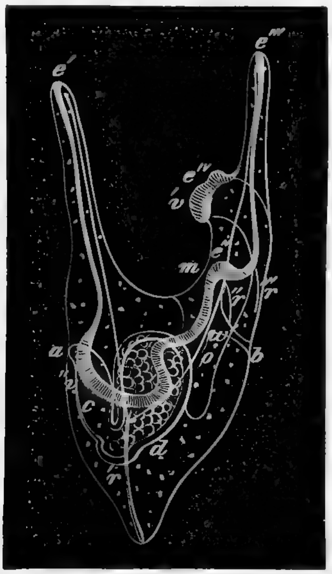


FIG. 52.

size of the water-tubes; but at the same time it becomes a puzzling matter to trace the limits of these tubes, owing to the delicate walls which bound them. Their presence can only be traced by the fine line which runs across the œsophagus from each side, and by the water-pore and the tube leading to it (*b*, *Fig.* 51). In a profile view of a pluteus considerably older than that represented in *Fig.* 50, the epaulettes (r'', *Fig.* 51) have assumed a more independent position, forming a curve somewhat similar to the arc from which the median anal arms of the Brachiolaria are developed; the third pair of arms bulges out quite prominently (e^{IV}) when seen in profile; the fourth pair of arms is visible (e''); the rod which eventually extends in the interior of it is a straight rod (r'') with a slight point in the middle, at present disconnected from the remaining part of the calcareous framework. This set of rods and

the fork r''', which extends into the arms e^{IV}, take their origin independently of the main rod which extends from the anal part round the mouth, and from which branches are sent into the arms e' and e'''. The rod r'' ultimately combines with the main system, but the rod r''' always remains separate from the others. The position of these rods is better understood when seen from the aboral side (*Fig.* 52).

The stage represented in *Fig.* 52 is particularly important, as it is at this time that we notice the first trace of what I suppose becomes the tentacular

Fig. 53.

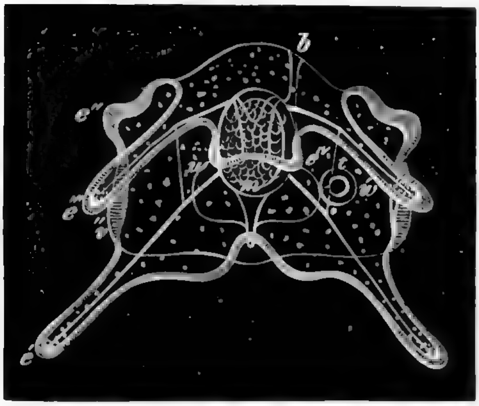
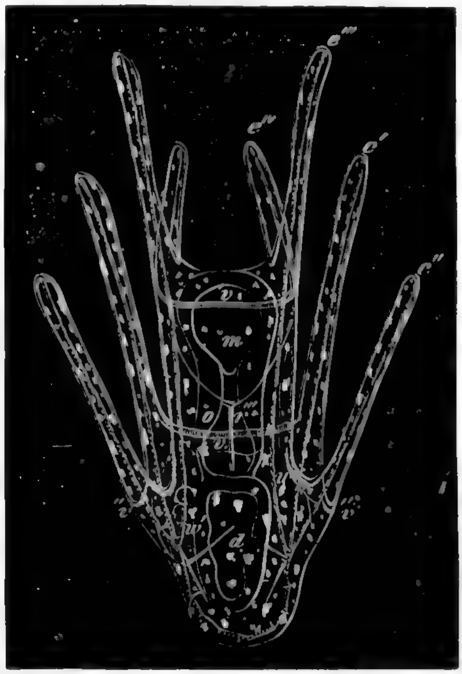


Fig. 54.



pentagon of the young sea-urchin. On the left water-tube we notice a very prominent loop *t*, which, from its resemblance to the tentacular loops of Brachiolaria, and from its position on the water-tube connecting with the water-pore, I have no hesitation in considering to be the first tentacular loop formed. Compare Figs. 1, 2. Plate VII. of Müller's seventh Memoir,* where he figures a similar tentacular loop in two different stages of development; unfortunately there is nothing in the text to explain what Müller considered it to be. The relation of the loop to the madreporic body is perfectly plain in this same pluteus seen from above as it floats in the water (*Fig.* 53), the epaulettes appearing like great flaps extending between the

* Müller, J., Ueber die Gattungen der Seeigellarven. Berlin, 1855.

base of the arms e' and e'', in continuation of the chord of cilia extending along these arms.

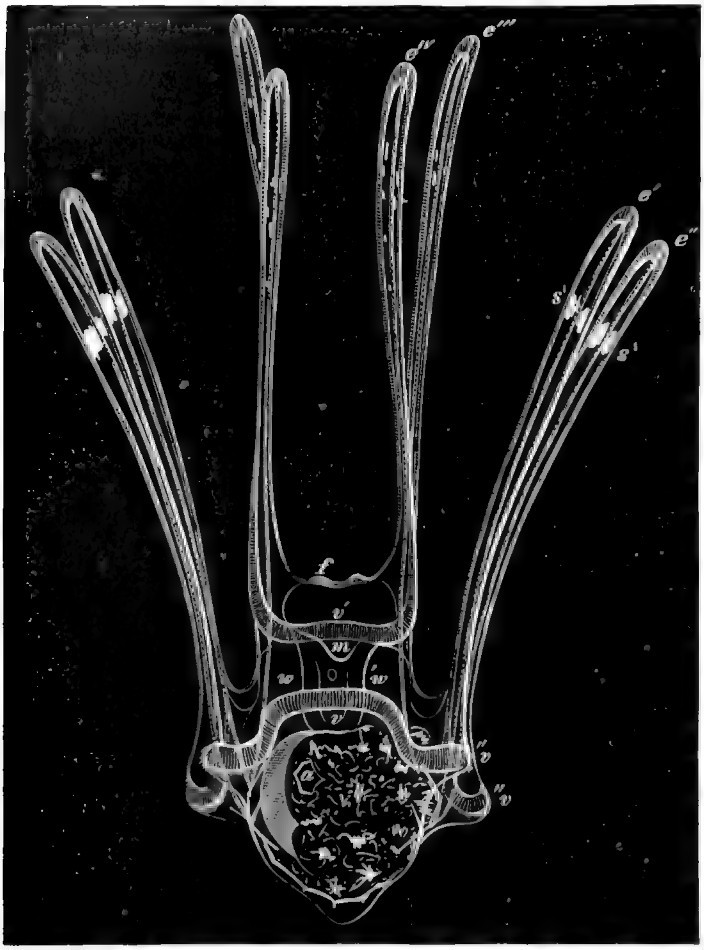
Figs. 52, 53, represent embryos twenty-three days old; during the next four days no change of any importance could be perceived; the tentacular loop remained the same, the arms alone increasing in size, and a few dark pigment spots appeared in the arms. Unfortunately, at the end of these four weeks the young embryos all died. I have only once succeeded in keeping them such a long time, and that was during the coldest winter weather. In the attempts made in the spring, whenever a warm day came, it was sure to kill everything; while in the summer, though the facilities I had were infinitely greater, I never could keep these embryos alive more than three or four days. The sea-urchins spawn during the whole year. Successful artificial fecundations have been made in December, January, and during every month from that time till the middle of October.

The remaining observations on the development of this species were all made from specimens caught swimming on the surface of the water; this applies to the fully-formed sea-urchins as well as the pluteus, only some of the most advanced specimens (*Pl. X. f. 2; Pl. IX.*) were found thrown up on the beach after a storm, attached to Laminaria. The specimens obtained in this way, the various stages of which were traced until there could be no doubt to what species they belong, connect so nearly with specimens obtained from artificial fecundation as to leave but few gaps to fill in the plutean condition to give us all their transformations. The sea-urchins raised from embryos caught swimming freely about were kept in confinement until they had attained the size of some of the more advanced nomadic sea-urchins (*Pl. X. f. 2*). This can leave no doubt to which of our two species of Echini these embryos should be referred.

The next oldest pluteus, which is *Fig. 54*, shows that since the last stage represented the principal changes have taken place in the oral part of the pluteus; the arms e'', e^{IV}, especially, have greatly increased in length, the outline of the anal extremity is somewhat rounded, the rod which runs along its edges is made up of short, stout pieces with strong pointed projections, and the rods of the arms are composed of three rods connected together by transverse spokes: it requires close examination to distinguish this. On the aboral side two very prominent spurs project over the stomach, somewhat below the point of junction of the rods of the arms e', e'', e'''. Additional tentacular loops have been formed; we can distinctly trace three on

the surface of the left water-tube w' ; the outline of a part of the right water-tube (w) shows great increase in the volume of the tube. In an adult sea-urchin pluteus (*Fig. 55*), the sea-urchin has encroached so much on the anal extremity as to conceal the shape of the digestive cavity. The spines are so large that we are unable to trace the position of the tentacular system; the anal opening is very conspicuous. The vibratile epaulettes (v'') are remarkably powerful. The arms have attained nearly the same length. The vibratile chord has been twisted in such a manner as to assume the appearance of binding an anal and an oral plastron, of which e', e'', e''', and e^{IV} are respectively the arms; the mode of formation of the chord and of the arms shows that all these arms in reality belong to one plastron (see *Figs 47, 48*), notwithstanding the great resemblance to the two distinct plastrons of a Brachiolaria. Two very prominent black spots are seen in the arms e', e'', similar to those observed by Müller in his Pluteus quadrimaculatus; a few small spots are scattered over the other arms. The pluteus figured here in its natural attitude does not undergo any further changes of form; it now enters a stage when the sea-urchin goes through its greatest transformations; these unfortunately cannot be followed, owing to the opacity of the embryo.

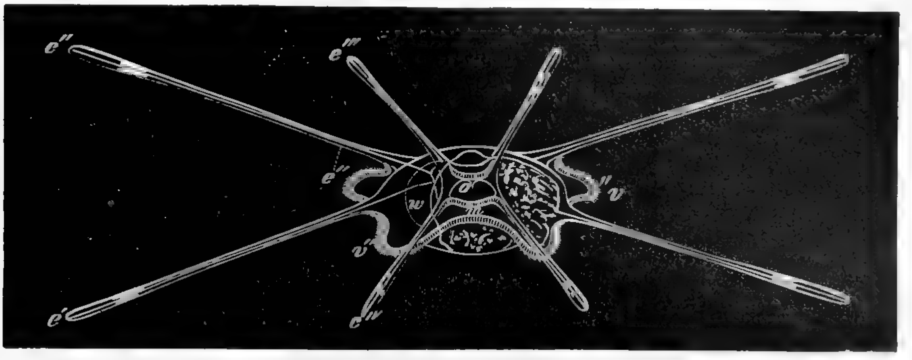
Fig. 55.



The presence of rods in the plutean forms of Ophiurans and Echinoids of course restricts considerably the play of the arms in assisting the motion of the pluteus. The arms cannot be bent and twisted in the graceful manner so

peculiar to Brachiolaria. They are only capable of opening and shutting like the rods of an umbrella. *Fig. 56*, which is *Fig. 55* seen from above, when left in its natural attitude, shows the extent to which the arms can be spread. This does not prevent the pluteus from moving quite rapidly (a sort of glid-

Fig. 56.

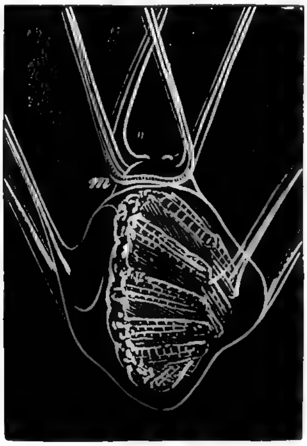


ing motion), principally by means of the vibratile epaulettes, which perform an important part in propelling the pluteus. While moving, the anal extremity is usually kept downward; this is the position which has been given to all the figures in this Memoir, and it is their *natural position*. Previous to the time when the anal extremity is loaded down by the development of the sea-urchin (*Figs. 36–54*), it is quite common to see them moving in every possible attitude, so that it would be difficult, from a knowledge of the earlier stages alone, to ascertain with precision what the natural attitude is; although we notice, even in the early periods, a very strong tendency to assume the natural position of the adult pluteus. The embryos also assume during their movements the oblique position described in Brachiolaria; this seems characteristic of all the Echinoderm embryos I have had occasion to examine, whether Ophiuran, Holothurian, Echinoid, or Asterian. A natural profile view of an adult pluteus (*Fig. 57*) cannot be made with great accuracy, and the outline here given is added simply to show the position of the arms; rotating as they do almost continually on their vertical axis, we catch only passing glimpses of the exact profile outline. The only adult pluteus figured in profile by Müller is found on Plate V. of his seventh Memoir.

Fig. 57.

An adult pluteus, in the condition of *Fig. 55*, requires several weeks for the complete development of the Echinus and the resorption of the plutean framework. The Echinus encroaches gradually on the anal extremity; the base of the arms e' and e'' is soon lost in the midst of the spines of the young sea-urchin, which are arranged in a conical, open, spiral wreath, surrounding the mouth (*Fig. 58*). While this encroachment of the anal extremity is going on, the œsophagus has contracted to such an extent that the base of the oral arms e^{IV}, e''', is brought directly in contact with the anal vibratile chord. During the process of resorption the arms have lost their mobility; they appear like helpless rods, stretching at every conceivable angle from the pluteus, which has lost entirely its former symmetrical appearance (*Fig. 58*).

Fig. 58.



The figures given by Müller on Plate III. of his first Memoir* represent several Echinoid embryos in which the young Echinus has resorbed more or less of the plutean frame. From what I have observed on several of these embryos, the pluteus is as completely resorbed as is the case in the Brachiolaria observed by me. Not a single part of the framework is thrown off; the process of resorption begins at the base of the arms; they are thus gradually shortened, the rods apparently melt away before our eyes, the extremity of the arms is the last to disappear; and immediately before the time when the young Echinus is freed from the plutean appendages, the extremities of all the arms are still there, as perfect as when these appendages stretched symmetrically on both sides of the longitudinal axis. From many of the figures of Müller himself it is evident that, in the embryos he has observed, the young Echinus resorbs the whole of the framework, and does not separate from it by losing the arms, as he has stated. (See Plates III., IV., V., VI. of his first and Plate VIII. of his seventh Memoir.) The pluteus represented in *Fig. 55* was kept in confinement from the 1st of October to the 20th of November before every trace of the arms had disappeared, when the young sea-urchin had assumed the appearance of *Pl. IX. f. 1*. This was drawn from a specimen found floating on the surface in the middle of June. This young sea-urchin bears a striking resemblance to a young Arbacia figured by Müller on Plate IV.

* Müller, J., Ueber die Larven und die Metamorphose der Ophiuren und Seeigel. Berlin, 1848.

of his seventh Memoir. The development of the separate parts is very different in the two. The number of spines is much greater in our sea-urchin, and they are of an entirely different shape. Pedicellariæ are likewise present in Arbacia; these do not make their appearance till a much later period in our young sea-urchins (see *Pl. X. f. 2*). What is particularly characteristic of these earlier stages of the young sea-urchins is the great size and small number of the spines. Their position is also peculiar; they are all placed on the edge of the test, which is exceedingly flat. (Compare this with Podophora.) Five of the tentacles are strikingly prominent, equalling in length the diameter of the test; they are also remarkable for their great thickness, and the presence of a calcareous ring in the sucker, which is entirely wanting in young starfishes. A similar calcareous ring is figured by Müller, Plate IV., fig. 13, seventh Memoir, and Plate VII., fig. 2, first Memoir. The whole abactinal surface is thickly covered with dark crimson pigment-cells. The younger spines resemble those of the young starfish (see Emb. Starfish, Pl. VI., Pl. VII.), while the more advanced spines are not fan-shaped, but slightly pointed, reminding us of the spines of Cidaris. On turning a young sea-urchin on its actinal side (as in *Pl. X. f. 2*), we find near the base of each of the five large tentacles four others, which are not as advanced, and are incapable of expanding beyond the edge of the test.

Additional spines are formed on the abactinal side of the test of older specimens (*Pl. X f. 4*), so that they cover the whole of that surface, and are no longer limited to its edge, as in *Pl. IX. f. 1;* the large spines become more pointed, the tentacles grow slender, and they can all expand beyond the edge of the test. The odd tentacle expands and contracts to a remarkable extent, — sometimes as much as three times the radius of the test. The four other tentacles are somewhat more stout, and not capable of such extensive expansion and contraction; the pair of tentacles placed nearest the mouth is the stoutest. The position of the tentacles is best seen from the actinal side (*Pl. X. f. 3*). The whole actinal surface is covered with a plating of limestone cells, which leave but a small circular opening, the mouth, in which the points of the teeth project. The actinal system is circular; there are no notches for the passage of the gills, as in adult Echini; the ambulacral tentacles are placed one above the other on each side of the median line. The long spines move in every direction, as they are already provided with the peculiar ball-and-socket joint of Echinoids. On removing the spines of one of these young sea-urchins, the great size of the

tubercles (*Pl. IX. f. 2*) and the large circular actinal system give them an aspect totally different from what we are accustomed to associate with the genus Strongylocentrotus. The teeth (*Pl. IX. f. 2*) fill but a small part of the actinal system; they are five narrow triangular wedges, extending from the centre to the edge of the actinostome, covered partially by the network of limestone plates (*Pl. IX. f. 2*). The test thus denuded of its spines resembles in all the general features that of a Cidaris. With the exception of the formation of the abactinal system, which is not yet developed, the striking features of the young sea-urchin — such as the circular actinal system, its large size, the great prominence of the tubercles, the position of the pores one above the other — are all characters belonging to a different family from that to which the adult sea-urchin belongs. The little sea-urchin does not long retain these anomalous features; with every day of increasing age the changes which it undergoes bring it closer and closer to the condition of the adult. In a young sea-urchin of a diameter of one fifteenth of an inch (*Pl. X. f. 2*), the spines have lost almost entirely their embryonic character, the tentacles are much more numerous, and pedicellariæ have made their appearance; in the interambulacral space they are more thickly scattered than in the ambulacral, where there are merely three or four. The abactinal system consists of a single large plate covering the opening of the anus, which opens on one side of it. The additional spines and plates which have been formed are all developed from the abactinal region. The new coronal plates are added in a spiral manner round the anal plate by additions to the limestone mass, pushing farther away from the abactinal pole the first-formed plates. The outline of the new plate is at first indicated on the lower edge, which becomes somewhat undulated; then the transverse divisions are made, and a spine is formed on the plate soon after that. There are no spines on the last-formed plates. The spines when they first appear have the same fan-shaped character as the earliest-formed spines of the abactinal surface (*Pl. IX. f. 1; Pl. X. f. 3, 4*). This shape they lose soon, and pass at once into spines resembling the older ones in every respect except size.

The mode of formation of new coronal plates was discovered by Professor Agassiz as early as 1834, when he gave a short account of it in the Edinburgh Philosophical Journal. The spiral arrangement of the plates is still very plainly visible in adult specimens. Although the sea-urchins are circular, we have in their mode of growth something which reminds us of the

earlier embryonic stages of the starfish. I have described in Part III. the various stages of growth of the young sea-urchin, — how it passes from the stage of *Pl. X. f. 2* to the condition when the pores, instead of being arranged in single rows one above the other, are placed in arcs on both sides of a median ambulacral row covered with spines. We can form a tolerably accurate idea of the changes the young must pass through by examining the abactinal part of the ambulacral area of an adult sea-urchin. The ovarian and ocular plates are early formed round the single anal plate by indistinct radiating and transverse sutures. The oldest of the young sea-urchins has advanced sufficiently to enable us to see that the subsequent changes required to make it agree with its adult condition are by no means as great as the changes which the young sea-urchin has undergone up to the present time. It has reached a condition which assures us that we deal with a young Strongylocentrotus, and nothing else. The pigment-spots, so marked in the younger stages, are smaller and scattered more uniformly; the muscular band around the mouth is well developed; the plate covering the actinal area has been separated from the edge of the test, and is moved by the muscular membrane which covers the actinal system. There are no notches as yet in the actinal part of the test. The teeth have not changed their form from that found in the earlier stages: there are from seven to eight tubercles in each vertical row of the ambulacral and interambulacral zones. I was unable to distinguish among the many tentacles the original odd tentacle which was so prominent in the younger stages. Neither have I succeeded in determining the position of the eye in any of the stages of these young sea-urchins, owing to the early presence of the spines and of the large pigment-cells, which prevent us from obtaining a favorable view of the odd terminal tentacle in the young forms; the odd terminal tentacle retains its original position during the whole life of the sea-urchin, as is the case in the starfish. I can say nothing concerning the development of additional ambulacral tentacles, as they are covered by limestone plates; but as in the early stage they are simple loops of the main ambulacral tube, they undoubtedly increase in number at the base of the odd tentacle, as in Asteracanthion (see Plate VI., Embryol. Starfish).

The figures of young sea-urchins given by Müller belong, unfortunately, nearly all to different suborders from our sea-urchin (Strongylocentrotus), so that we cannot make the comparison with our young sea-urchins as close

as we might wish. The figures of Müller are not drawn in such a way as to discriminate between the parts which belong to the ambulacral and to the interambulacral spaces. This is particularly evident in his figures drawn from the mouth side, where we frequently find such a number of tentacles represented as make the development of the different ambulacra unequal. The same is the case with the spines. Any one who will take the trouble to compare the figures of young sea-urchins of Plates IV. and VII. of his first Memoir, Plate VII. fourth Memoir, and Plate IV. seventh Memoir, with the figures given here (*Pl. IX. f. 1 ; Pl. X. f. 2–4*), will see that, although they

Fig. 59.

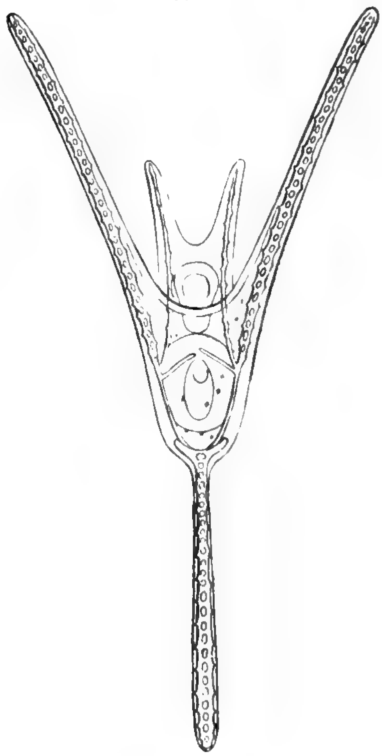
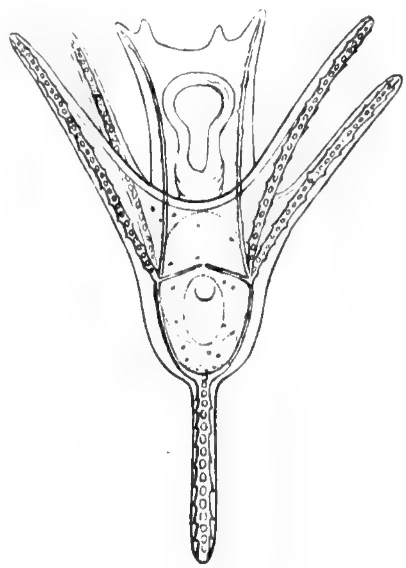


Fig. 60.



agree in their general characters, yet it is impossible to place the different spines or tentacles in such positions that they can be divided into ambulacral and interambulacral areas, while this is easily done with the figures I have given. We must remember, however, that most of Müller's figures are Clypeastroids and Spatangoids, which may make it difficult, if not impossible, to divide the young sea-urchin into ambulacral and interambulacral areas, in suborders where we have nothing like regular vertical rows to guide us, as in our common sea-urchin. One great difference, however, will strike us at once ; it is, that what Müller has called the anus I have in my figures called

the mouth. The view he has taken is probably due to the fact that the young sea-urchins from which he made his drawings were compressed. Having fol-

FIG. 61.

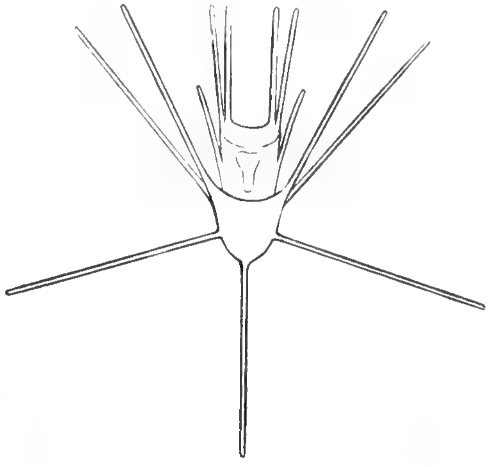


FIG. 62

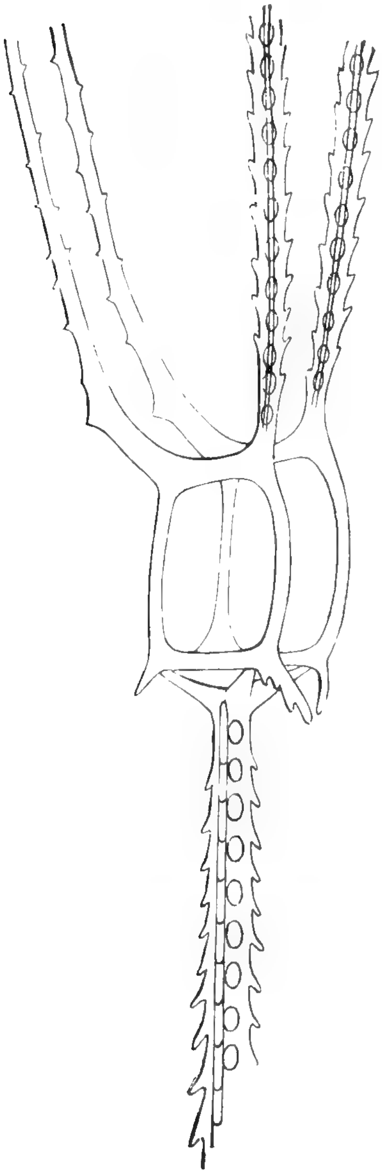
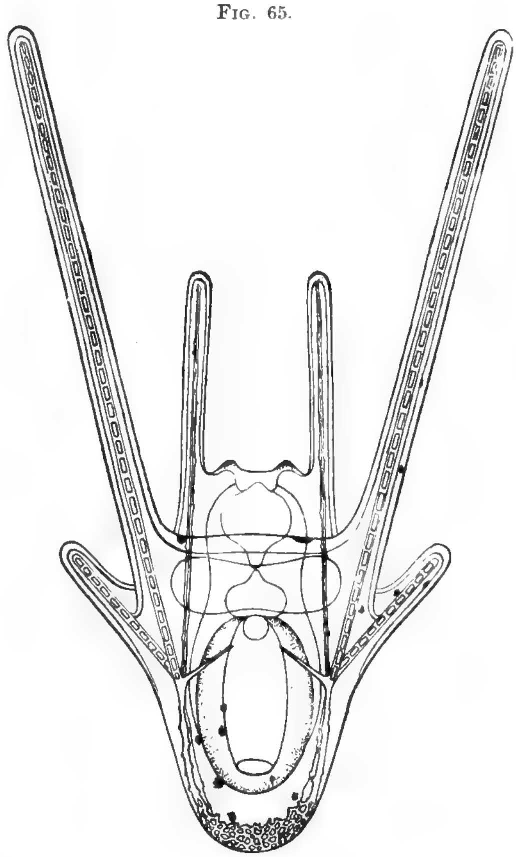


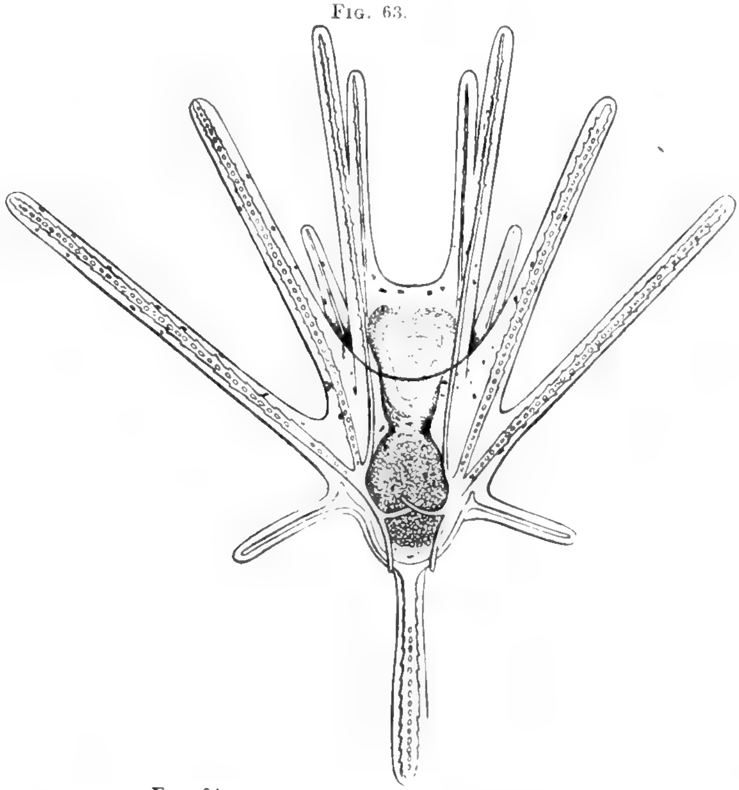
FIG. 65.



lowed the mouth in the different stages which have been represented here, I think there can be but little doubt that Müller was mistaken. Compare *Pl. X. f. 3* of this Review with his Fig. 3, Plate VII., first Memoir, and we

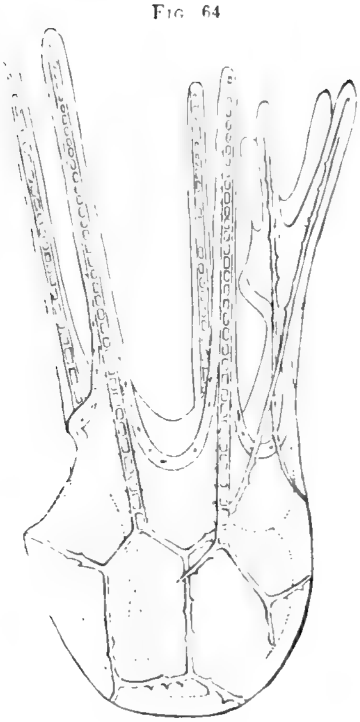
cannot fail to come to the conclusion that it is the mouth which is turned towards us in both cases. If Müller's statement were correct, we should have

Fig. 63.



the anomaly in young sea-urchins of finding all the tentacles placed between the spines and the anus, on the abactinal side of the test, while on the actinal area we should have nothing but a closed membrane. This is so contrary to the plan of development of Echinoderms, whether Echinoids, starfishes, or Ophiurans, from the observations of Müller himself, that I give the above explanation,

Fig. 64



which seems to bring the figures of Müller in accordance with what I have observed. The appearance of the teeth, in Müller's figures, on what seems the abactinal side, is due to compression also. The spines of the young sea-urchins observed by Müller have a very uniform appearance; they are nearly all hexagonal prisms in their earliest stages. The same is the case with our young sea-urchins, though they lose their embryonic character at an earlier period than is the case in any species observed by Müller.

We know unfortunately too few of the embryos of Echini to be able to compare the pluteus of the different orders. From the little we know we find very extensive differences. The pluteus of the Spatangoids, as far as we know them from

Müller and Metschnikoff, are remarkable for the long process (*Fig. 62*) developed in very early stages (*Figs. 59, 60*), and which seems, as far as known, eminently characteristic of the Spatangina. The embryos of Schizaster (*Figs. 59–61*, copied from Müller) differ very strikingly from the pluteus of the regular Echini. The small size (*Fig. 61*) of the arms and their uniform size are in marked contrast to the extraordinary development of some of the arms in Arbacia (*Fig. 66*) and Strongylocentrotus (*Fig. 55*). This seems to be the final condition of the pluteus in the oldest known Spatangoid embryo, in the pluteus of Schizaster, as well as in another Spatangoid pluteus (*Fig. 63*), probably Echinocardium.

Fig. 66.

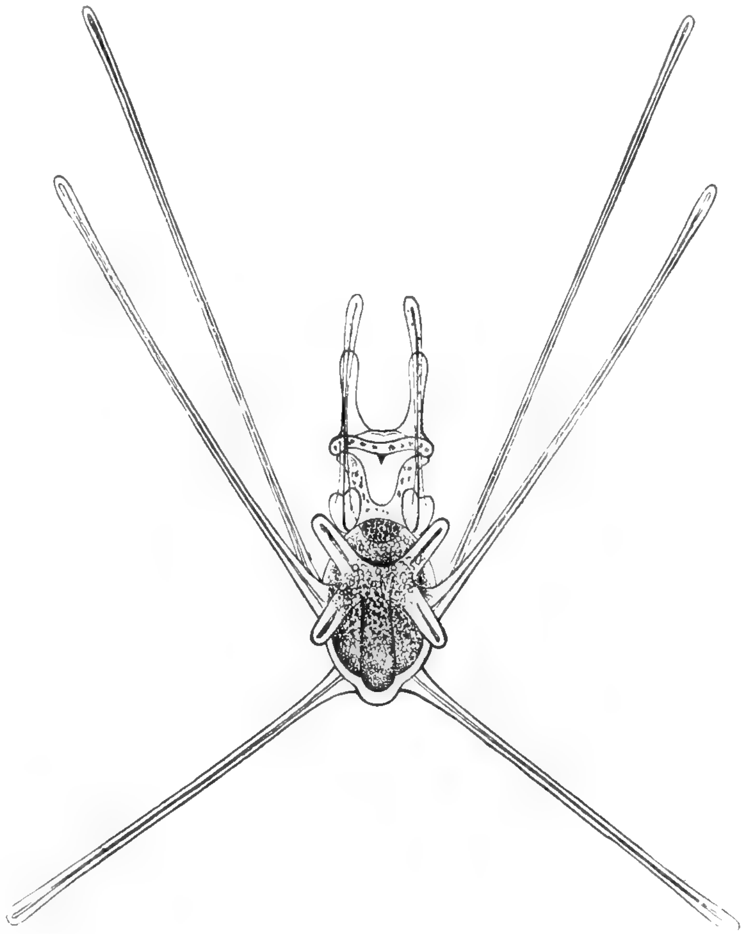
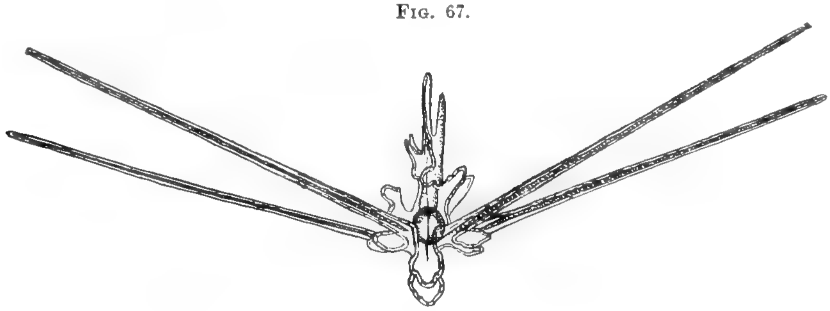


Fig. 67.



The pluteus of the Clypeastroids is not known with certainty. Müller figures in his seventh Memoir (Plate VIII., fig. 4) a larva which he considers

that of Echinocyamus. This pluteus (*Fig. 64*) is remarkable for its rounded extremity and the compact space filled by the œsophagus and stomach. The only other Echinoid pluteus known to me which may be a Clypeastroid embryo is that which I have figured in *Fig. 65*. It has, like the pluteus of Echinocyamus, a rounded lower extremity, the same compact alimentary system, and arms arranged in pairs. *Fig. 65* is most probably the pluteus of Echinarachnius. It is quite common at Newport, R. I.; as the embryos of Strongylocentrotus and of Arbacia, the two other Echini common in Narragansett Bay, are well known, it can only be the pluteus of Echinarachnius, which abounds along the sandy shores of the bay. It has a certain analogy to the so-called Echinocyamus pluteus; at any rate, it is a remarkably distinct type from either the Spatangoid or the regular Echinoid pluteus.

Among the Desmosticha the embryos of several species of Echinus and Strongylocentrotus have been figured, showing striking differences. How far these differences are of systematic value cannot be stated, as the embryos known represent only a few of the families of Echini. No embryos of Cidaridae or Diadematidae have as yet been observed. The pluteus of the Arbaciadae is well known from one of the most complete Memoirs of Müller. A few additional points on the development of Arbacia have been observed by Metschnikoff. The pluteus of our Arbacia punctulata, which is tolerably common at Newport, R. I. (*Fig. 66*), differs somewhat from the pluteus of Arbacia figured by Müller, but not more than the pluteus of closely allied species would be likely to differ. From this pluteus (*Fig. 66*) the young Arbacia figured on page 734 was developed in about three weeks. The young Arbacia was most remarkable, differing very strikingly from the young Arbacia figured by Müller, which he also raised from the pluteus. The only other type of pluteus known is a remarkable one, closely allied to Arbacia, which has been figured by Müller (*Fig. 67*). From what has been said we have evidently, as far as known, quite marked types of embryos corresponding more or less to the several subordinal and family divisions recognized among Echini.

ON THE YOUNG STAGES OF ECHINI.

To complete the history of the development of Echini just given, I add here the main portions of the sketch on young Echini given in my Preliminary Report on the Florida Deep Sea Echini, with references to the plates of this Revision. A detailed account of the changes due to growth will be found in the description of each species.

In Cidaris (*Pls. I., II., II^c.*) the difference between old (*Pl. I.; Pl. II. f. 1–3*) and young stages (*Pl. II^c. f. 7, 13*) is almost entirely limited to the proportionally larger size of the spines, and the more prominent serrations (recalling Salenia). The abactinal system early assumes the character of the adult; in fact, with the exception of the smaller number of coronal plates, the above differences in the spines are the only important changes undergone in this genus. The same holds good for Diadema (*Pl. IV^a. f. 1*) and Echinothrix (*Pl. III^a. f. 1–3*); in both genera the spines are proportionally larger and less numerous: this gives to young Diadematidae a peculiar facies, Echinothrix calamaria-like (*Pl. II^c. f. 6*). We find also in young Diadema characters in the actinal membrane differing from those of the adult; the peculiar grouping, in five separate clusters, of the buccal ambulacral plates which appear first, is soon lost by the encroachment of the smaller interambulacral plates, and in older specimens the plates become deeply imbedded in the buccal membrane. This feature is always retained in the genus Centrostephanus. The pores at first are placed in a vertical row in very young specimens (*Pl. VI. f. 15^a*); they then become arranged in arcs of three (*Pl. VI. f. 15*) or four pairs; with increasing age the median rows of interambulacral tubercles assume the arrangement existing in the adult (*Pl. VI^a. f. 5*). Owing to the rapid growth of the spines in the young, the extremity, and frequently the greater part of the spine almost to the base, is hollow; but as the young increase in age they become more solid at the base, and farther up in proportion to their age (*Pl. XXXV. f. 10*).

In the Cidaridae and Diadematidae the structure of the spines forms a good basis for the discrimination of groups, notwithstanding their apparent great changes of form. The variations do not extend to the nature of the ornamentation, which remains very constant, and will prove of great value in fossil Echini.

In Strongylocentrotus Dröbachiensis, soon after resorption of the pluteus the young sea-urchin has few large primary tubercles, limited to the ambitus, Podocidaris and Colobocentrotus-like (*Pl. IX. f. 1*). The next stage has two principal rows of large tubercles, — occupying the whole test (*Pl. IX. f. 4*), Cidaris-like, no miliaries, — increasing in number as they grow older, the spines gradually passing from a condition similar to those of Rhabdocidaris (*Pl. X. f. 2–4*), Cidaris, Arbacia, and finally to Strongylocentrotus-like spines (*Pl. X. f. 1*), as fast as the primary tubercles are formed, retaining their embryonic features most strongly while the spines are directly connected to the test (*Pl. X. f. 2–4*), as they are in Podocidaris. In the earlier stages the actinal opening is large (Arbacia-like), without indentations (*Pl. IX. f. 2–4*), Cidaris-like, occupying nearly the whole of the actinal surface. As the test increases this opening becomes proportionally smaller, and slight cuts are formed (*Pl. IX. f. 10*), Echinus-like. The anal system is at first closed by a single subanal plate (*Pl. X. f. 2*), appearing before the formation of the genital and ocular plates; it remains for a considerable period more prominent than the other plates, which are gradually added to cover the enlarged anal system (*Pl. IX. f. 3, 6, 7*). The symmetrical axis of the subanal plate does not hold a fixed relation to the madreporic body, being opposite different genital plates in various stages of growth. This corresponds to the oblique position of the subanal plate in Salenidae (*Pl. III. f. 11*), when we take as starting-point the madreporic body. The abactinal system subsequently passes through a stage (*Pl. IX. f. 11*) reminding us of Arbacia (*Pl. V. f. 2*) and Trigonocidaris (*Pl. IV. f. 1*), only there are five instead of four anal plates. The poriferous zone is at first narrow, the pores arranged in vertical rows; subsequently they are slightly arched vertically (*Pl. IX. f. 5*); they next separate into horizontal arcs made up of a smaller number of pores, increasing rapidly in number with age (*Pl. IX. f. 9*); in small specimens we can trace their mode of formation, as the arcs near the ambitus are similar to those of the adult, while those next the abactinal system are similar to those of the younger stages. The plates of the poriferous zone increase independently of the interambulacral plates. The different stages of growth represent in the younger stages combinations of features strongly recalling at first Cidaris (*Pl. IX. f. 2*), next Hemicidaris, then Pseudodiadema, Arbacia, and Stomopneustes. The same general changes take place in Strongylocentrotus lividus; the turban shape (Cidaris state) of the young test is even more striking than in Strongylocentrotus Dröbachiensis.

Nowhere among the young regular Echini have I found such great changes in the shape and proportions of the test and spines as in Echinometra. We frequently find specimens of the same size, where in one case the outline is almost circular, the test flattened, covered with long slender spines, while in the other the test is lobed, swollen, high, surmounted by numerous short stout spines (*Pl. X^a. f. 2, 3*). These and all intermediate stages, complicated by the greater or smaller number of primary tubercles, are found retained in specimens of very different size; the arrangement of the arcs of the poriferous zone undergo changes exactly similar to those described in Strongylocentrotus. This has given rise in a great measure to the confused synonymy attached to the most common species of the genus, and renders their identification, if based upon meagre material, almost hopeless.

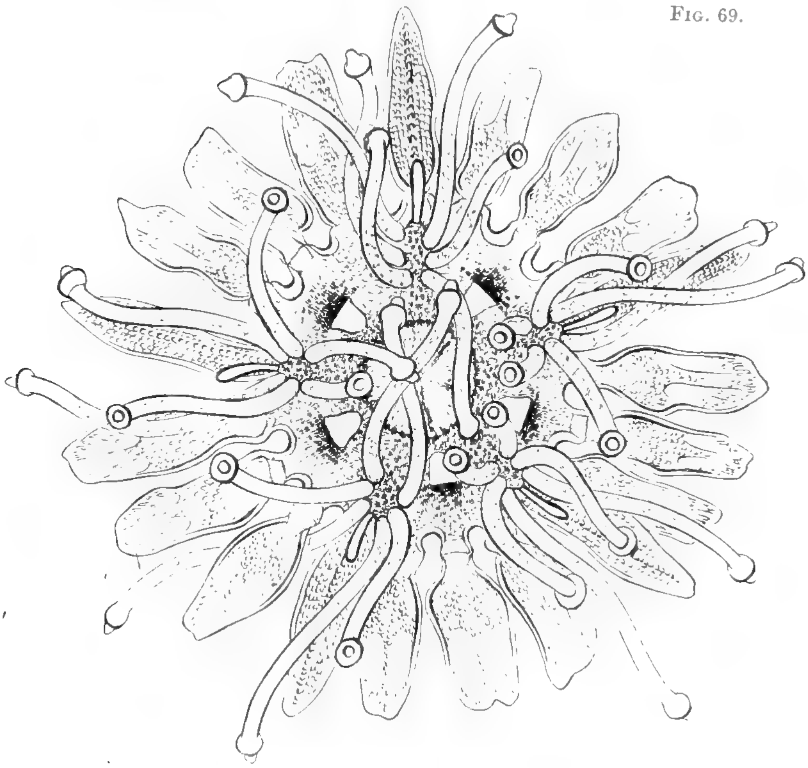
In young Arbaciadae (*Pl. V. f. 9*) we have already in the youngest stages four anal plates. I have traced (*Fig. 68*) in the youngest Arbacia raised from the pluteus the first appearance of the anal plates, which appear simultaneously as four lines radiating from the apex, and forming the separations of the four anal plates (see *Fig. 68*). The abactinal system of young specimens is remarkably prominent, occupying more than one half the abactinal part of the test. The whole test is deeply pitted (*Pl. V. f. 11*), Trigonocidaris-like; the rudimentary tubercles, covering the greater part of the abactinal part of the test, are connected by ridges, which are gradually resorbed and reduced to the granulation found upon the coronal plates of the genus (*Pl. V. f. 2, 14, 16, 18*). The primary tubercles are at first limited to the ambitus (*Fig. 69*), surmounted by short stout spines (*Pl. V. f. 9*), Colobocentrotus-like, gradually becoming more slender and proportionally longer with increasing age (*Pl. V. f. 12, 14, 17*), — the opposite of what takes place in Strongylocentrotus, Cidaris, and most young Echini. The rudimentary spines are not seated upon tubercles; they are club-shaped (*Pl. V. f. 9*), identical in structure to those of Podocidaris (*Pl. IV. f. 13*). The poriferous zone has in the earliest stages the structure found in the adult, only it does not widen at the actinostome (*Pl. V. f. 15*). The ratio of the actinostome to the test does not vary greatly in different stages of growth; the edge of the actinal system forming the groove of the gills is but slightly turned back in the young, the lips, taking the place of cuts, becoming more prominent (Toxopneustes-like) with increasing age (*Pl. I^g. f. 6*). Owing to the independent growth of the plates of the poriferous zone from those of the interambulacral system, we have either three or four pairs of pores for each

ambulacral plate; the same is the case with other Oligoporidae, as limited by Desor, showing that the division he has made, although convenient as a key for the easier grouping of genera, is yet not strictly reliable, the mode of growth of many Polyporidae showing in their young stages that they have but a small number of pores (Hipponoë, Mespilia) for each ambulacral plate, which places them among the Oligoporidae; but, owing to the independent growth of the plates of the poriferous zone, they seem in older stages to belong to the Polyporidae. In the chapter on the water system I have given an account of the mode of increase of the number of plates of the poriferous zone in several genera. In all of them the independent development of the plates of the ambulacral and interambulacral systems is very marked; their independent growth has, subsequently to the publication of my Preliminary Report, been observed by Lovén.

Fig. 68.

Figs. 68, 69. Young Arbacia punctulata, diam. 1.5mm. including spines.

FIG. 69.



In Echinus, Sphaerechinus, Toxopneustes (*Pl. VII., VIII.*), we find in the younger stages the same unbroken vertical arrangement of the pores (*Pl. VII. f. 8, 11*), taking next a vertically arched form (*Pl. VII. f. 2, 4, 15, 22*), still connected, and then assuming the arrangement of the adult. In these genera the anal system is at first covered by one plate only (*Pl. VII. f. 9*), and undergoes changes similar to those of Strongylocentrotus, by the addition at first of four smaller plates (*Pl. VII. f. 1, 10*), and so on (*Pl. VII. f. 5, 17, 18*), the original subanal plate retaining long a greater prominence (*Pl. VII. f. 3, 6*). The miliaries, in these genera as well as in Strongylocentrotus, are formed by radiating ridges arising from the base of the primary tubercles, forming a sort of star; then they swell at the distal extremity, forming a set of club-shaped spokes round the main tubercle; these are little by little separated from it, and become independent elliptical tubercles at first, and then miliaries or secondary tubercles (*Pl. VII. f. 2, 8, 11, 15*). The ten large buccal plates of the actinal membrane are the first to appear, as in Strongylocentrotus (*Pl. IX. f. 2, 4*), Toxopneustes (*Pl. VII. f. 7*), and Temnechinus (*Pl. VIII. f. 17*). Small plates (in genera in which they are

found in the adult) are next formed between them and the teeth (Echinus-like), while afterwards they cover the whole membrane, as in Toxopneustes (*Pl. VII. f. 20*), and some of the species of Echinus and Trigonocidaris (*Pl. IV. f. 2*), appearing between the ten plates and the test (*Pl. VII. f. 3, 11, 14*). This mode of growth is totally unlike the growth of the movable imbricating buccal plates of the Cidaridae (*Pl. II^c. f. 9, 11*), where these plates perform the part of ambulacral and interambulacral plates, and appear near the test at first, forming in full-grown specimens rows made up of more than two plates, as in the Palaechinidae, suggesting that the test of Palaechinidae must have been made up of plates homologous to the buccal plates of Cidaris. The test, of course, would then have been capable of considerable compression and change of outline, as is the case in Astropyga and Asthenosoma. This similarity is very striking in young Cidaridae, where the number of coronal plates is small, and the young sea-urchin seems to consist almost entirely of an abactinal and an actinal system, separated by a narrow band of coronal plates.

In some species of Temnopleuridae the subanal plate remains very prominent, even in adult specimens (*Pl. VII. f. 23*); the anal system in the young is covered by one large elliptical plate; as the anal system enlarges, numerous minute plates surround the larger plate (*Pl. VII. f. 24′*), which always retains its peculiar ornamentation, and is readily distinguished from the others by its size and shape. In others, on the contrary, the anal system undergoes changes identical with those of Strongylocentrotus, Echinus, and the like. In Temnopleurus the pits at the angles of the plates appear at first like rectangular openings (*Pl. VIII. f. 24*), which, as the specimens grow older, become little by little connected by grooves, growing deeper and more prominent with advancing age (*Pl. VIII. f. 22, 25*). In another species of the genus the pits are never so marked in the adult, becoming simply comma-shaped (*Pl. VII. f. 26*). The miliaries of the Temnopleuridae are formed, as in other genera, by ridges appearing at first connected with the base of the primary tubercles (*Pl. VIII. f. 4, 11, 14, 22, 24*). In Trigonocidaris the young (*Pl. IV. f. 7*) differ from the old (*Pl. IV. f. 3*) in having larger pits, less numerous and lower ridges, and but few secondary tubercles, the principal rows of ambulacral and interambulacral tubercles being very prominent. The buccal membrane and the abactinal system present no striking differences; there were only four anal plates in all the specimens collected. In Temnechinus, of which an extensive series was collected, we find in the

smallest specimens a few large spines (*Pl. VIII. f. 16*), resembling the spines of young Dorocidaris hystrix, equalling in length the diameter of the test. As the specimens increase in size, the spines lose their spindle-shaped form and their serrate edge; they become more pointed and elongate (*Pl. VIII. f. 5, 12, 18*), diminishing rapidly in proportion to the size of the test, and soon take the proportions they have in the adult. The actinal opening is very large at first, the test in young specimens being a narrow ring when seen from the actinal side (*Pl. VIII. f. 7*). The primary tubercles are few in number, with remarkably prominent ridges radiating from them (*Pl. VIII. f. 14*), leaving deep pits between the ridges. With increasing size these ridges become miliaries and secondary tubercles, the pits, however, remaining round the boss of the primary tubercles in both the areas (*Pl. VIII. f. 4, 11*); so that the test passes through stages in which it resembles at first young Echinus, then an Echinus with deep grooves radiating from the tubercles, and finally with deep pits round their base. The original subanal plate (*Pl. VIII. f. 10*) retains always its preponderance (*Pl. VIII. f. 3*), and the embryonic character of the anal system is a marked feature of this interesting sea-urchin. The actinal opening rapidly becomes smaller (*Pl. VIII. f. 2, 9, 15*), and resembles that of Echinus. In fact, Temnechinus might be called an Echinus among Temnopleuridae, while Temnopleurus is the Toxopneustes of the family.

The changes taking place in the arrangement of the pores in Hipponoë and Toxopneustes are similar to those observed in Echinus: at first a simple vertical row, then arcs laterally curved (*Pl. VIII. f. 29*), then three pairs of pores for each ambulacral plate, in oblique open curves, and finally almost horizontal curves, the pores appearing to be placed in independent vertical rows.

Among the Clypeastroids we find in the young during their growth great changes of form and structure taking place. In young Echinarachnius (*Pl. XII. f. 1–4*) the outline is elliptical, the test is arched and high, the anus is placed in a slight depression of the test, and, seen in profile (*Pl. XII. f. 3*), we are reminded of the general aspect of Pygorhynchus. There are but two principal rows of large tubercles in each area, extending from apex to mouth, so that, seen from above (*Pl. XII. f. 1*), the young Echinarachnius has much the facies of an Echinometra (*Pl. XII. f. 2*). The mouth is large, pentagonal, its radius being half the radius of the test. The ambulacral rosette is reduced to two pairs of pores, — simple perforations of the test,

one in each poriferous zone for each ambulacrum. This extraordinary shape and structure the young do not retain long; they soon become pyriform (*Pl. XII. f. 5, 6*), the blunt extremity being the posterior; the test becomes greatly flattened and the anus approaches the edge. The rosette is now composed of three and two pairs of simple pores in each poriferous zone for each ambulacrum, the anterior ambulacrum having only two pairs in each zone. The tubercles are proportionally smaller, though there are still only two rows in each area, but farther apart. In the next stage (*Pl. XII. f. 5, 6*) we find the rudimentary rosette composed of four and five pairs of pores close together, and two or three distant pairs of pores, in the following ambulacral plates, one pair in each plate, which in subsequent stages increase in number and extend almost to the edge of the test. The test has become quite flattened; the lower side is concave, undulating; the ambulacral zones are now much narrower than the interambulacral ones. Each plate still has only one tubercle; the lines of separation between the two zones run straight from the edge of the test to the apex. It is only in somewhat older stages (*Pl. XII. f. 10*), when the rosette loses its radiating outline, and assumes a slightly petaloid shape, that we find the angle formed in the adult at the base of the petal in the ambulacral zone; from this point the ambulacral plates widen rapidly; each plate now carries from two to six smaller tubercles. The outline is quite pentagonal; the lower surface concave, but little undulating. The anus is placed near the edge, and covered, as in all preceding stages, by a single plate (*Pl. XII. f. 11*); the anal system in older specimens has five plates (*Pl. XII. f. 12, 12'*), the plate first formed remaining somewhat the largest. As the young Echinarachnius increases in size its outline becomes more circular, and in specimens measuring one fifth of an inch in diameter has the general appearance of the adult (*Pl. XII. f. 13*). The furrows joining the ambulacral pores appear soon after the first traces of a true rosette are seen; they become deeper and the pores separate in proportion to the petaloid structure of the abactinal part of the ambulacrum. The tubercles are proportionally much smaller and more numerous, and soon after the ambulacra have a well-developed rosette, and nearly bear to the plates the ratio which they have in the adult.

Young specimens of Mellita hexapora, measuring $\frac{3}{32}$ of an inch in diameter, are almost circular, with a thickened raised edge, as in Laganum, and as yet have no lunules (*Pl. XI. f. 1*). The rosette is simply a series of radiating pores, three and two in each poriferous zone, for each ambulacrum, extending

but a short distance from the apex. The ambulacral and interambulacral plates are of the same size, hexagonal, forming twenty equal zones, carrying but a single large tubercle in the centre of each plate; seen from below the surface is deeply concave, the mouth much larger in proportion to the test than in adult specimens. We see forming from this side the posterior interambulacral lunule as a deep pit (*Pl. XI. f. 2*), at one extremity of which, near the mouth, is placed the anus, about one third the distance from the edge of the test. We find also rudimentary phyllodes made up of a few of the small pores, which eventually extend in the ambulacral furrows to the edge of the test, but are now restricted to a small number clustered round the mouth. The outline in a subsequent stage becomes slightly pentagonal, the plates elongate; the lunule pierces through to the abactinal side (*Pl. XI. f. 3*); the rosette is also radiating, made up of five to six pairs of pores for each poriferous zone. The ambulacral area is now slightly narrower than the interambulacral zones. When the posterior lunule has become a small round opening, encroaching upon the plates of the posterior interambulacral area. extending as a lobe beyond the outline of the test, the rosette is slightly petaloid (*Pl. XI. f. 7*). There are from two to five tubercles on each plate; these are quite elongate, having lost their hexagonal outline; the lower surface is flat, and on the lower side the ambulacra have broadened very rapidly. the interambulacra forming narrow bands carrying larger tubercles between the ambulacral zones. The edge of the test is still quite thickened, and it is only when the young Mellita has attained somewhat less than half an inch in diameter that the ambulacral lunules appear as pits, seen at first from the lower side only (*Pl. XI. f. 10*), and gradually forcing their way through the test (*Pl. XI. f. 9*) to the abactinal side. The posterior interambulacral lunule increases rapidly in size; the test and the groove in which the anus is placed become somewhat separated from it, being simply a depression in the continuation of the lunule (*Pl. XI. f. 4, 6, 8–10*). After the appearance of the lunules as slight pits, which develop unequally and do not appear simultaneously, the changes are limited to the increase in size of the lunules and of the ambulacral poriferous zone on the lower side; the outline and general facies (*Pl. XI. f. 10–12*), with the exception of the larger size of the tubercles, being that of the adult.

The general character of the changes undergone by Echinarachnius and Mellita hexapora, as far as they relate to the transformations of the ambulacral rosette, the growth of the tubercles, the changes in the proportions of

the relative breadth of the ambulacral and interambulacral zones, are identical in Mellita testudinata and Encope emarginata. What is remarkable in Mellita testudinata is that the mode of formation of the ambulacral lunules is not identical with that of M. hexapora. The interambulacral lunule alone (*Pl. XI. f. 15, 18*) is developed from a depression formed on the lower surface pushing its way through the test, while the ambulacral lunules are the result of the closing in of notches appearing on the edge of the test, which remain open until the young Mellita has attained a considerable size (*Pl. XI. f. 19*), — three quarters of an inch and sometimes more; long after the arrangement of the plates, the shape of the rosette, the size of the tubercles, and the extent of the poriferous zone on the lower surface have the character of the adult. In fact, the mode of development of Encope and of Mellita testudinata, as well as of Mellita longifissa (*Pl. XI. f. 24–27*), is far more closely allied than that of the two species of Mellita of the types of hexapora and testudinata.

In Encope emarginata we have, as in Mellita, an early stage in which no posterior interambulacral lunule exists (*Pl. XII. f. 14*). The outline of these young Encopidae is not Laganum-like, as in Mellita, but is elliptical, as in very young Echinarachnius; the ambulacral zones, extending uniformly from the edge to the apex, are narrower than the interambulacral (*Pl. XII. f. 14*). The plates of both areas carry one to two large tubercles and a couple of very small ones. The ambulacral pores extend from the apex to the mouth. One pair of pores, not connected by grooves, is situated in the suture of each ambulacral plate. The outline seen from above is deeply scalloped (*Pl. XII. f. 14, 15*), — in fact, it is a Moulinsia, — and the figure given by Agassiz in the Monographie des Scutelles is only a young Encope emarginata. The posterior interambulacral lunule commences as a pit from the lower side (*Pl. XII. f. 15*), and by the time the young Encope has attained a diameter of three quarters of an inch, the lunule is seen from above (*Pl. XII. f. 17*) as a small elliptical opening. The edge of the test is deeply scalloped, especially at the median ambulacral sutures, where notches soon appear, and the young Encope gradually takes a deeply lobed outline (*Pl. XII. f. 17, 20, 22, 24*). These cuts may or may not close, and thus we have the basis of the great number of species established upon the depth of lobes, the presence or absence of certain lunules, which are nothing but features of the young either retained in the adult or greatly exaggerated. The ambulacral rosette is formed as in Mellita and in Echinarachnius by the independent growth of the

upper part of the ambulacral area, which in Clypeastroids grows more rapidly than the rest of the test, from the moment the pores are joined by grooves, the plates crowding upon one another, and pushing them, or a part of them, towards the edge of the test (*Pl. XII. f. 19*). In the Scutellidae the pairs of pores of the rosette are placed in the sutures of the ambulacral plates (*Pl. XI. f. 22*), while in the Clypeastroids, besides the pair of pores in the sutures, an additional pair pierces the middle of each ambulacral plate (*Pl. XI. f. 23*).

The development of the flat Clypeastroids and of the Scutellidae as above described is most instructive, showing that we must introduce a complete reform among such genera as Lenita, Scutellina, Runa, Echinocyamus, and other minute Echinoids, which may eventually prove to be nothing but the young of other Clypeastroids, probably of Mellita, Scutella, Laganum, Clypeaster, Echinanthus, Encope, and the like; but want of sufficient material prevents me from entering into this comparison more in detail. We know now, from what has been said above, that the Scutellidae pass through phases which cannot be distinguished from Moulinsia, Fibularia, Runa, Scutellina. For this reason I am inclined to consider Fibularia as the early stage of some Clypeastroid. The absence of partitions in some species can, I think, easily be accounted for, as they are developed only in later stages. We have a species of Fibularia from the Sandwich Islands, in which there are no partitions when they are very small, while in the adult these partitions are most rudimentary. Greater material than I possess is necessary to elucidate the affinity of the genus, which certainly has all the features of immature Clypeastroids.

The young of Clypeaster subdepressus are pentagonal, with rounded angles (*Pl. XIII. f. 10*); with increasing age (*Pl. XIII. f. 16–18*) the concavity of the lower side is more marked, the partitions increase from the addition of needle-shaped processes, and they soon attain the shape and have the structure given by Lütken in his figures of young Clypeaster subdepressus. The tubercles increase more rapidly near the edge of the test, and a remarkable feature of these stages is the presence of minute glassy tubercles similar to those of Echinonëus, developing side by side with young tubercles, the function of which is as obscure as it is in Echinonëus; they are not found in older specimens.

The development of Echinolampas has thrown unexpected light upon the affinities of the toothless Galerites and of the Cassidulidae. It shows con-

clusively that Echinonëus is only a permanent embryonic stage of Echinolampas, thus becoming allied to the Cassidulidae, and that it has nothing in common with the Galerites as I would limit them, confining them entirely to the group provided with teeth. This reduces the type to a most natural division, and from what we now know of the simple nature of the ambulacra of all Echini in their early stages I would not give to this feature the significance which it has received, but would be inclined to unite the toothed Galerites with Echinidae proper in the same suborder, approaching the Clypeastroids on account of the separation of the anus from the apical system, and retaining the teeth and general symmetrical structure of the regular Echini; though I am aware that the great development of Galerites in former geological periods, and the relation of the anus and test, may, on further acquaintance with living representatives, entitle them to rank as a suborder intermediate between the Echini proper and Clypeastroids. Young Echinolampadae, measuring a trifle over one eighth of an inch, are elliptical (*Pl. XVI. f. 1*), resembling Echinonëus, with a large transverse elliptical mouth (*Pl. XVI. f. 2*); the anus is placed in the truncated posterior extremity above the ambitus. The outline in profile is almost globular (*Pl. XVI. f. 3*); each plate of the narrow ambulacral zone carries a single primary tubercle, surrounded by a circle of miliaries (*Pl. XVI. f. 4*). The pores are arranged in a vertical row of a single line of pores, three or four for each plate, extending from the mouth to the apex (*Pl. XVI. f. 4*). The interambulacral plates are elongated horizontally, and carry from one to three principal tubercles, with numerous small miliaries arranged in circles round the primaries, or irregularly scattered. In specimens twice the size of the above, the test is less elliptical, more flattened, and the first trace of a rudimentary rosette appears as a short row of double pores extending from the apex, consisting of from eight to nine pairs (*Pl. XVI. f. 6*). In one of the poriferous zones of each of the pairs of ambulacra — in the anterior zone of the posterior pair and the posterior zone of the anterior pair of ambulacra — the odd ambulacrum remains simple. In specimens measuring above half an inch this rudimentary one-sided rosette has increased in length, and traces of the second row of double pores are seen in the simple zones near the apex. In specimens measuring an inch these rows have grown to be half as long as the arc of the rosette first formed (*Pl. XVI. f. 21*); the same structure has also extended to the abactinal part of the odd ambulacrum. The elliptical outline is entirely lost in these specimens, the shape having gradually become more circular, pentagonal, and

ovoid. At the same time the miliary tubercles increase rapidly in number, forming clusters of small tubercles, embossing the plates of both areas. The anal system is covered by three large triangular plates (*Pl. XVI. f. 5, 14*), the anus opening near the edge of the system, in a narrow slit covered by very minute plates. The mouth, as the young increase in size, becomes more and more sunken (*Pl. XVI. f. 9, 18, 20*). The buccal membrane is covered with minute plates (*Pl. XVI. f. 9*), the mouth opening in the centre. There are as yet no signs of phyllodes or of bourrelets, which appear only later, the bourrelets being at first accumulations of small tubercles between the phyllodes (*Pl. XVI. f. 20*). When measuring about half an inch in length, the young Echinolampas resembles Caratomus to such an extent (*Pl. XVI. f. 8–10*) that this stage was considered for a time a living representative of Caratomus. The larger series collected by Mr. Pourtalès in his second expedition showed conclusively the relationship to Echinolampas, and proves the correctness of the step taken by Desor in removing Caratomus and allied genera from the Galeritidae, and placing them among the Cassidulidae, on account of the semipetaloid nature of the apical portion of the ambulacra.

Among Spatangoids proper, the examination of young specimens shows that they undergo great changes in outline during their growth; that the posterior part of the test is especially subject to variation; that the position of the anus is exceedingly variable in one and the same species; that the mouth is not labiate in the young as in the adult; that the peripetalous and lateral fascioles do not greatly change their limits, but that the subanal and anal fascioles are subject to extreme modifications during their growth, and cannot be used as distinctive features of generic value, while the permanence of the peripetalous and lateral fascioles is of great systematic value. The ambulacral petaloids also are greatly modified with age, generally becoming confluent, while in the young they are remarkably distinct and the pores not conjugated. The Cassiduloid-shaped mouth of young Spatangoids (*Pl. XVII. f. 13, 16; Pl. XIX. f. 13*), as well as the existence of several Spatangoids, both fossil and recent, in which the mouth has a similar structure, is as convincing a proof as necessary of the correctness of uniting Cassiduloids and Spatangoids in the same suborder.

Young Brissopsis lyrifera, less than a quarter of an inch in length, are cylindrical (*Pl. XIX. f. 1–3*), the mouth having a flat, crescent-shaped edge, the test is truncated vertically at the posterior edge, surrounded by a prominent elliptical subanal fasciole; the peripetalous fasciole is elliptical, undulat-

ing; the anus is placed near the posterior extremity of the fasciole. The odd ambulacrum carries four or five large tentacles with a lobed disk (*Pl. XIX. f. 2*); the pores of the odd ambulacrum are single, not in pairs; the other ambulacra are short, straight, well defined, consisting of three and four pairs of pores not yet conjugated (*Pl. XIX. f. 7*). In older specimens the posterior edge of the mouth becomes labiate; the anus approaches the subanal fasciole, which sends out a rudimentary anal branch (*Pl. XIX. f. 4*), eventually uniting with the peripetalous fasciole, the outline of which becomes more pentagonal, undulating, and elongated with the increasing size of the petaloid ambulacra (*Pl. XIX. f. 7–9*). The posterior edge becomes more bevelled with age, the subanal plastron more prominent, the lateral pairs of ambulacra gradually tend to unite (*Pl. XIX. f. 9*), passing from a strictly Brissopsis outline to one considered hitherto characteristic of Toxobrissus. The spines in all young Spatangoids are less numerous and strikingly larger, in proportion to their size, than in the adult (see *Pl. XIV., XVI., XVII., XIX.*).

In Echinocardium cordatum the changes of the mouth, of the outline of the internal ambulacral fasciole, and the gradual confluence of the lateral ambulacra, are similar to those of Brissopsis; the posterior extremity undergoes the greatest change in outline; the subanal plastron is very prominent (*Pl. XIX. f. 14*); in fact, the outline of young Echinocardium cordatum recalls Echinocardium gibbosum. The subanal fasciole and the anal branch are originally united (*Pl. XIX. f. 14*), but as the specimens increase in size, the anal branch separates from it (*Pl. XIX. f. 17*). The odd ambulacral pores are at first two single rows of pores (*Pl. XIX. f. 15*), which by closer crowding eventually alternate (*Pl. XIX. f. 16*), but are not arranged in pairs.

The young Agassizia, a quarter of an inch in length, is a flat elliptical Spatangoid resembling Gualteria (*Pl XIV. f. 9*). The peripetalous and lateral fascioles have the same general limits as in the adult; the arrangement of the pores is identical in all the ambulacra; there is but a single pore for each ambulacral plate (*Pl. XIV. f. 11*) as it exists in the anterior pair and odd ambulacra of the adult; the ambulacral grooves are not yet formed, the anterior groove alone is slightly indicated; the mouth is not labiate (*Pl. XIV. f. 10*).

A great number of Spatangoid genera are established upon differences existing in the subanal fasciole, the presence or absence of the anal branch, the depth of the ambulacral grooves, the confluence or distinctness of the lateral ambulacra, — all characters subject to great variation during growth. This

shows the necessity of a careful revision of the whole group of Spatangoids with the data here furnished. Such closely allied genera as Maretia (*Pl. XIX^b. f. 7*), Spatangus (*Pl. XIX^c. f. 5*), and Macropneustes; Eupatagus (*Pl. XV^a. f. 3*) and Metalia (*Pl. XXI^a f. 4*); Meoma (*Pl. XXII. f. 3*), Linthia (*Pl. XIX^a. f. 7*), and Faorina (*Pl. XIX^a. f. 4*); Agassizia (*Pl. XIX^a. f. 1*), Prenaster, and Periaster; Tripylus (*Pl. XXI^c. f. 4*) and Schizaster (*Pl. XXIII^a. f. 3*); Gualteria, Brissopsis (*Pl. XXI. f. 2*), and Hemiaster (*Pl. XXI^c. f. 1*), and many others, both recent and fossil, must be re-examined and critically revised before we can attempt an arrangement of Spatangoids into natural families and genera.

A general comparison of the changes Echini pass through during their growth, after they have resorbed the pluteus, brings out strikingly the sudden transitions which take place during the development of an individual. For although we can trace the gradual changes by which the young sea-urchin imperceptibly passes from one stage of growth to another, yet there are periods of growth showing such marked differences that they strike us more forcibly, and seem, as it were, to be sudden jumps from one stage of development to the next, owing to the rapid changes of some of the more prominent points of structure. Very slight changes frequently give a totally different facies to a young sea-urchin, so that the gap between the extremes will seem very great; but when carefully analyzed the differences disappear, and we are then more struck with the affinities than with the contrasts, which seemed so marked at first glance.

A few instances will suffice to explain my meaning. To begin with, who would have suspected the genetic relation of the pluteus with the Echinus? The pluteus, an eminently nomadic stage, a scaffolding in which the future sea-urchin plays but a secondary part, and is composed of two open spirals, the one to form eventually the complicated abactinal system (the interambulacral and ambulacral plates), the other to form the water system, and holding between them the digestive cavity and other organs of the pluteus, which as yet appear to have no connection whatever with the spines of the future Echinus. Yet towards the end of the nomadic pluteus life a few hours are sufficient to resorb the whole of the complicated scaffolding, which has been the most striking feature of the Echinoderm, and it passes into something which, it is true, we could hardly recognize as an Echinus, yet has apparently nothing in common with its former condition. In the subsequent stages contrasts nearly as striking occur. The Cidaris stage (*Pl. IX.*

f. 1) of Strongylocentrotus is in marked opposition to the old specimens (*Pl. X.*). The different stages of growth of Arbacia (*Pl. V.*) differ more than many of the genera recognized among Echini. The successive stages of growth of Toxopneustes are very unlike. The young Temnechinus (*Pl. V. III. f. 16*), although we have traced its gradual passage to the stage of *Pl. VIII. f. 1*), will always seem most closely allied to Arbacia. We naturally refer the striking phases of growth to forms with which we are familiar, and which, correctly or not, have been recognized as independent genera. Hence we are led to draw the inference either that the widely different forms are genetically connected because their analogues have apparently passed during their embryonic growth from one stage to the other, or that it is still possible, even in widely differing forms, that a genetic connection should exist, owing to the sudden transitions which we see going on during the development of an individual.

The Scutellina stage (*Pl. XI. f. 1*) of Mellita seems at first glance very distinct from the Monophora (*Pl. XI. f. 3*), from the Ravenellia (Lütk.) (*Pl. XI. f. 19*), or from the true Mellita stages, yet on a close analysis these stages are all due to very slight structural changes, although they are so different at first glance and apparently are not linked by intermediate stages, if examined simply as we should examine them on the supposition of their being adults. The petaloid and simple ambulacra only differ in quantity; the mere spreading of the median interporiferous zone produces differences in the ambulacral system which have been used to distinguish not only genera, but even families. This is especially the case in the Clypeastroids and Spatangoids, and shows that the Galeritidae, apparently so distinct from all the other Echini, are most closely allied to the Clypeastroids, having their tubercles, their disconnected anal system, the simple ambulacra of the young Clypeastroids, and having besides the notches of the actinal system of Echini proper. The position of the anus, a most striking feature, is of little consequence, as during the growth of the young Echinus we find it passing from an actinal to an abactinal position, and it would be most natural to separate widely forms in which the anal opening should in one case be situated next to the mouth, as it is in the stage immediately following the pluteus stage, and in the other when placed at the opposite pole from the mouth, as in our Strongylocentrotus. The unstable position occupied by the anal opening is well shown in the different stages of Echinarachnius (*Pl. XII.*).

In the Spatangoids the apparently sudden transitions, resulting from the more rapid growth while passing from a stage of comparative rest to a succeeding stage of slow growth, are best shown in the development of Echinolampas (*Pl. XVI.*). The stages this genus passes through extend over a very great range, and suggest affinities and identities previously unsuspected. We can trace the mode of transition of the simple ambulacra of Galeritidae and of Echinonëus to the petaloid ambulacra of the majority of Spatangoids, the mode of formation of the bourrelets from an eminently Clypeastroid actinostome, and the changes which transform the simple radiating pores of the ambulacral system round the actinostome to the more complicated phyllodes of the Petalosticha ; showing that stages we have been accustomed to consider as emphatically distinct, when compared as adults or as occurring in distinct genera, may be brought about by very slight modifications of apparently little consequence at the time of their origin in the growth of an individual, but which, proceeding very rapidly, end in producing marked changes before they reach the next period of rest.

By making a similar comparison between the extremes as known from recent and fossil species of Echini and intercalating intermediate recent and fossil forms, the conclusion has been drawn that we must eventually find all or most of the intermediate unknown forms between apparently disconnected types, if the theory of evolution be correct, because so many of the missing links have been found in our more recent explorations both on the land and in the depths of the sea. Such a conclusion seems to me unwarranted. On the contrary, judging from the analogy of the development of living species, we can only say that the genesis of the species may have been homologous to the development of the individuals as we know it from embryological data, and that we shall always find gaps in the fossil series (even were they all known) which cannot be filled on the supposition that there is a genetic connection between them.

GEOLOGICAL SUCCESSION OF THE ECHINI.

The earliest Echini known, the Palaechinidae, appear in the Silurian period. They are thus far the only Echini discovered up to the time of the Trias. The number both of the genera and species is comparatively small. In the same formations, associated with them, are found Starfishes, Crinoids, and Ophiurans; as far as described, the differences between these orders, in the earliest formations of the Palæozoic period, were fully as great as those existing at the present day. All we know regarding the early Echinoderms is, that the Crinoids were infinitely more varied than they are in the subsequent formations, and by far the most numerous of the Echinoderms, while the Starfishes, Echini, and Ophiurans were less numerous. This same numerical proportion is maintained throughout the Palæozoic period till we come to the Trias, when we are suddenly introduced to a genus which has undergone but little change to the present day, — the genus Cidaris, — and which takes its greatest development in the Jurassic period. Associated with it, and preceding it in time, we find plates of Echini (Echinothuriae), quite closely allied to the Perischoechinidae (they appear in the Carboniferous period), of which traces have been discovered in the Cretaceous, and of which representatives are still extant in our times.

What is specially characteristic of the Secondary period — the Trias, Lias, and Jura — is the sudden appearance of types totally dissimilar in structure from any of the Echini found in the geological epoch preceding it, — the sudden appearance of the early types of Spatangidae, such as the Dysasteridae, which have absolutely no relationship with the genera preceding them in time; what is particularly remarkable is their appearance before the so-called transition forms between the regular Echini and the Spatangoids, the Galerites. In fact, though the theoretical genesis of the Spatangoids from the tessellate Echini can be most satisfactorily evolved, the data unfortunately do not in the least accord with it, and the actual occurrence of Collyrites before Holectypus and before the Cassidulidae leaves us completely at a

loss to account for the appearance of the former genus by derivation. During the Trias a few genera, such as Hemicidaris and Hypodiadema, appear, which are closely allied to the Cidaridae proper; as early as the lower jurassic beds we find other generic types, still extant at the present time (Hemipedina), with genera closely allied to the Diadematidae, Echinidae proper, as well as the Cidaridae. These genera (the Pseudodiadematidae) have culminated in the Cretaceous period, and have gradually disappeared during the Tertiaries. The remarkable development of the Cassidulidae is a striking feature of the lower jurassic beds, especially the occurrence of such genera as Clypeus, Echinobrissus, Pygurus, side by side with the Dysasteridae of the preceding periods, which disappear in the upper cretaceous beds, though Spatangoids closely allied to them are still found in the Tertiaries (Infulaster); and even at the present day (Pourtalesia). The greatest development of the Cidaridae proper takes place in the upper jurassic beds; they continue through the Cretaceous and Tertiary periods to the present time, and they are still quite numerous in our tropical seas. In the upper jurassic beds they are, however, associated with a large number of species of Galeritidae, especially Holectypus and Pygaster, and with a number of Echinobrissidae and Dysasteridae. The number of genera common to the jurassic and the lower beds of the Cretaceous periods is great; here again we find, as in the passage from the Primary to the Secondary epochs, genera suddenly appearing (Toxaster and Holaster), closely related to the Dysasteridae, and belonging to a family (the Ananchytidae) which is a very characteristic one of the Cretaceous period, and has survived to the present time, — Paleopneustes, Homolampas. The Galeritidae continue numerous, and are represented in the chalk, not by Galeritidae most closely allied to the Clypeastroids or Spatangoids, but by Galeritidae most closely allied to the Echinidae proper. The early appearance of the Galeritidae, which I have shown to be eminently embryonic Cassidulidae, before the Cassidulidae, is one of the anomalies of the genetic succession, at variance with the theoretical derivation. From what we now know of the Galeritidae, since they have been shown to possess teeth and actinal cuts, they evidently are not so far removed from the Desmosticha as we might suppose. Their appearance in the Jurassic period coincides remarkably well with the idea that they form the connecting link, in the sense of sudden transitions, between the Desmosticha and some of the Petalosticha; for the embryology of Echinolampas has plainly shown us an early Discoidea stage, which is unmis-

takable and extremely suggestive of the closer affinities of the Cassiduloids and Galeritidae.

The Cretaceous period is characterized by the marked development of the Spatangoids proper. Of those with fascioles Micraster and Hemiaster are the first to appear; they recall most forcibly the embryonic and younger stages of Spatangus proper and of its allies, which now form the principal species with those recent Petalosticha which are generically traced back to the chalk. The generic types characteristic of the upper Cretaceous are already remarkably closely allied to those now living, and many of them are identical. The Cassidulidae, the Ananchytidae, the Schizasteridae, the Brissidae, the Spatangidae, are represented by genera passing through the Tertiaries, identical with those of the present epoch. The types which appear are all closely related to those immediately preceding in the lower Cretaceous formations. In the upper Cretaceous the earliest Clypeastroids are suddenly brought into life. They are, it is true, the genera Echinocyamus and Fibularia, the embryonic types of the Clypeastroids, and we might imagine a genetic connection between them and the Discoidea on account of the presence of teeth and the more or less rudimentary radiating partitions, and through the Discoidea to the regular Echini. But the late appearance of the Clypeastroids, long after the existence of many of the families of the Cassiduloids and of the Spatangoids, of which they should, according to the theory of derivation, have been the ancestors, is one of the principal features in the geological succession of the Echini, which at present can only be accounted for by the sudden appearance of the early Spatangoids.

As soon as we reach the Tertiary formation the similarity of the fauna to that now in existence becomes quite apparent, and it is more and more dissimilar from the preceding Cretaceous faunæ the nearer we approach the Quaternary period. In the Eocene we find many Spatangoids, — Schizaster, Brissopsis, Echinocardium, Breynia, Brissus, Eupatagus, Spatangus, Maretia, and so forth, which are still well represented in our seas, and suddenly come to light associated with such genera as Conoclypus, Hemiaster, Periaster, Pygorhynchus, and Echinolampas, which have continued to exist from the upper Cretaceous period, and most of which continue also to the present time; some of them were more numerous in species in earlier times, such as Echinolampas, Pygorhynchus, while Conoclypus does not extend beyond the Eocene. The characteristic genera of the Cretaceous period, the Galeritidae and the Dysasteridae, as well as the Ananchytidae, have disappeared,

and they are replaced in a measure by the smaller Clypeastroids, Lenita, Scutellina, and such Laganum-like genera. In the Miocene the large Clypeastroids, such as Echinanthus and Clypeaster, which first appeared in the Eocene, take a marked development and form the principal species; with them come to light the Scutellidae proper, until in the Pliocene the character of the genera is eminently recent, and we find such genera represented as Mellita and Echinarachnius among the Clypeastroids; the Arbaciadae, Salmacis, and Temnopleurus among the Desmosticha, while there are no genera of Petalosticha which have not already occurred in the Miocene. It is quite striking that when we compare the Cretaceous, Eocene, Miocene, and Pliocene genera with those of the present day we find a greater proportion of them in common the farther west we go. Many of the genera of the Nummulitic period in India are still found in the West Indies which are entirely extinct from the Pacific Ocean to the Mediterranean.

The close relationship existing between the present fauna and the later Tertiary period, the Pliocene, is best shown by a comparison of the representatives of the present West Indian fauna with the fossils known to occur in the Pliocene of the east coast of the United States and of the West Indies.

PLIOCENE.	WEST INDIES.
Cidaris armigera, MORT.*	Dorocidaris papillata.
(Coelopleurus) Echinus inflatus, MORT.	Coelopleurus floridanus.
Echinometra acufera, GUPPY.	Echinometra subangularis.
Scutella Rogersii, MORT.	. . . . ?
Mellita caroliniana, RAV.	Mellita testudinata.
Mellita ampla, HOLMES.	Mellita sexforis.
Clypeaster rosaceus, DUCH.	Echinanthus rosaceus.
Nucleolites Richardii, DUCH.	Rhynchopygus caribaearum.
Pygorhynchus jamaicensis, CONR.	Echinolampas depressa.
Echinonëus cyclostomus, GUPPY.	Echinonëus semilunaris.
Agassizia porifera, McCR.	Agassizia excentrica.
Brissus Scillae, GUPPY.	Brissus unicolor.
Plagionotus Ravenellanius, McCR.	Meoma ventricosa.
Plagionotus Holmesii, McCR.	Metalia pectoralis.
Amphidetus gothicus, McCR.	Echinocardium cordatum.
Echinocardium orthonothum, CONR.	Echinocardium flavescens.
Schizaster atropos, D'ORB.	Moira atropos.

A similar comparison has already been made by Forbes in his Monog. of the Brit. Tert. Echin. with those of the surrounding seas and the Mediterranean, and many of the species he proved to be identical. Two of the

* The authorities denote simply the specific determinations of the collectors.

genera of the Crag, Coelopleurus and Temnechinus, no longer found in the European seas, are still extant in the West Indies.

We cannot fail to be struck with the persistence of many of the types of the chalk up to the present time, either as identical or most closely allied genera. This was of course known from the time Lyell first called attention to the similarity of the fossils of the tertiary deposits with the present fauna; it has recently been brought up still more forcibly after several most marked Cretaceous genera, Salenia, Hemipedina, Phymosoma, Echinothuria, and Pourtalesia, were dredged from great depths in the West Indies, showing a much more intimate generic connection between the present time and the chalk than had been admitted.

We can, in fact, from the time of the Cretaceous period, draw up a table of genera, starting from the Desmosticha characteristic of that period, and ending in the Clypeastroids now found in our seas, which would answer all the requisites of a genealogical tree; but we cannot in like manner do the same for the Petalosticha except in a most general manner, and we find, as has been mentioned above, that the Petalosticha have existed long before the genera from which we might derive them have come to light; at least, as far as we know the genetic connection of living forms from their embryological development. The question of time, which has always been invoked as necessary to produce the great changes noticed between fossils occurring in successive formations, is not such an important one, as far as Invertebrates are concerned, as we imagine. We have two classes of phenomena which must have occurred side by side, genera retaining their generic features unchanged from the time of the Jura to the present day (the persistent types), and genera suddenly introduced, but differing from those already existing, except in the single instance of the appearance of the Dysasteridae, to a far less degree than the stages now known, from embryological data, to belong to one and the same species; these successive stages of growth follow each other in rapid succession, and pass through phases which appear more or less like sudden transitions from those immediately preceding them. The analogy between the sudden appearance of genera in their geological succession, and the sudden transitions observed in the growth of an individual during its different stages, is remarkable. Somewhat similar views regarding the nature of the changes which have brought about the sudden appearance of types have already been suggested by Nägeli, Kölliker, and specially by Heer.

It is indeed difficult to imagine, from the little we know regarding the habits of Echini, what are the ways in which natural selection is to act, not only upon them, but upon many of the lower marine animals of which the successive stages of life are so varied, and in which life is passed under such very varying circumstances. All that a careful study and comparison of the Echini, both living and fossil, enables us to assert is, that there is a marked coincidence between the geological succession of the generic types and the genetic succession observed during the changes due to growth; that in the growth and development of the species sudden breaks appear, similar to the gaps observed in the geological succession of the types of the best known strata. From this we are warranted in assuming that the mode of appearance of generic types in past ages is analogous to that observed in the history of the species. But how this appearance takes place we are as far from knowing as we are of giving the reason for the successive stages in the segmentation of the embryo.

It may not be out of place here to recall that Agassiz was the first to point out in his "Poissons Fossiles" the agreement existing between the paleontological and the embryological genesis, though he did not draw from it the conclusions of a common origin subsequently suggested by Darwin. It is astonishing that so little use has been made of the positive data furnished by embryology in support of the evolution hypothesis, and that so many of the supporters of the Darwinian theory have been satisfied to build castles in the air, which they have been obliged to pull down in rapid succession, till it is wellnigh impossible, in the present stage of the discussion of the embryological evidence, to sift from the best memoirs what has actually been observed, and what has no better foundation than a mere theoretical basis. To those who have followed the discussions of the embryology of articulates the above will not appear too strong a statement. It is only in a few orders of the animal kingdom that we have even the first beginnings of the needed paleontological and embryological material to serve as the basis for the comparisons which might lead to some definite results. Yet these comparisons are generally instituted on such a grand scale, and with such an utter disregard of the exceptions, that their authors can hardly expect us to follow them in the paths they tread, where theory takes the place of observation. No one appreciates more than I do that the explanation of the theory of evolution, as given by Darwin, has opened up new fields of observation in many departments of biology, the importance of which can hardly be over-

estimated. His influence on the progress of biology has been most beneficial, and he has, in connection with the embryologists, led the way for biology out of the mere systematic field which threatened at one time to stop all future progress. But his disciples cannot ask us to take as proved beyond question all the vagaries regarding this and that ancestor of the great types of the animal kingdom, about which they talk with such sublime confidence. And when I am introduced to an archetype in a group where we have neither paleontological nor embryological evidence, or when I am asked to believe in a genealogical tree of which neither the roots nor the branches have ever existed, as far as we now know, I am no longer dealing simply with an hypothesis, but with the wildest speculation.

Specialists are supposed to be least fitted to form opinions on general philosophical questions for which their investigations may have furnished valuable data. Yet, unfit as they may be to decide between two rival systems of philosophy, they should at any rate be credited with sufficient intelligence to know whether a theory accords with the facts in the case or not, and explains it satisfactorily. The supporters of Darwin, who outdarwin Darwin himself, seem determined not to imitate their great leader, and attempt, in the most dogmatic manner, to crush any argument brought forward, not by showing its worthlessness, but by simply taking it for granted that discussion is no longer possible.

HOMOLOGIES AND AFFINITIES OF ECHINI.

The general symmetry of Echinoderms has been fully discussed by Agassiz and Müller, and I am only repeating here facts which they have discussed from a somewhat different point of view. Their relation to Radiates is maintained by the former, while Müller considers the plan of radiation as entirely subordinate to that of bilateral symmetry, basing his arguments mainly on the structure of the plan of the pluteus; Agassiz, on the contrary, drawing his arguments entirely from the fully developed Echinoderm. There is no doubt that in the pluteus the bilateral symmetry completely overshadows the radiate plan, which does not become prominent till after the Echinoderm has passed through the pluteus stage, but then the plan of radiation completely overshadows the bilateral symmetry, which becomes only a secondary feature. Both Agassiz and Müller determine an anterior axis by means of the position of the madreporic body. I have already shown that this method did not lead to accurate results, and that in the regular Echini we had as yet found no means of determining an axis which should in all cases be homologous to the anterior axis of the Clypeastroids and Petalosticha. In the Echinometradae alone we find an apparent exception to this rule; yet when we compare Echinometra and Heterocentrotus we find, as I have pointed out, that the long and short axis, as determined by the position of the madreporic body, are not homologous in these two genera, although so closely allied.

The embryo Echinoderm only in its earliest stages, after the resorption of the pluteus, creeps upon the same surface whether it be a Starfish, Ophiuran, Echinus, or Holothurian. There is, very early in the life of many Holothurians, a distinct dorsal and ventral side, which serves as the sole upon which they creep, while in the Starfishes, Ophiurans, and the greater part of the Echini, the actinal surface remains always the one upon which the animal moves. In the Holothurians, as is well known, we have either apodous genera, or genera in which there are ambulacral feet in all the ambulacra, only more powerfully developed in the trivium which serves for creeping; or else the ambulacral feet are present only in the trivium, as in

Cuvieria, and we thus have a marked antagonism between a dorsal and a ventral surface. An anterior and a posterior extremity is of course definitely fixed in all Holothurians, but a right and left only in those genera in which the trivium forms a ventral surface in contrast to the less prominently developed bivium. The same is the case in Echini. It is only in those genera in which we find a bivium and a trivium that we have not only a right and a left, but an anterior and a posterior extremity. In the Galeritidae the structure of the ambulacra and shape of the test alone would not be sufficient to distinguish such a bivium and trivium as that of the Clypeastroids and Spatangoids, and were it not for the position of the anal system in one of the interambulacral spaces, we should have nothing to guide us in fixing the anterior or posterior extremity (as in the Desmosticha), much less a right or left. By means, however, of the outline of the test, of the position of the anal opening, and of the structure of the ambulacral petals, we can readily fix the position of the longitudinal and transverse axis, of the anterior and posterior extremity, and, of course, of right and left. In the Desmosticha the animal rests upon an equal actinal portion of the five ambulacral and interambulacral regions. In the Clypeastroids we find already a difference; the mouth is no longer in the centre, and the anterior part of the actinal surface is frequently larger than the posterior (Echinarachnius. Encope). In the Petalosticha the actinostome is always anterior, so that the disproportion between the growth of the bivium and the trivium becomes very considerable in such genera as Brissus, Metalia, and the greater number of the Spatangoids proper. We have therefore an actinal surface, the greater part of which is formed by the posterior interambulacral area (the actinal plastron), while of the trivium but a small part belongs to the actinal surface, and a somewhat larger part of the posterior lateral ambulacra. So that what constitutes the actinal surface in the Holothurians, Starfishes, Ophurians, Echini, and Crinoids (Comatulae) is by no means identical in the different suborders. In Comatulae the actinal surface corresponds to the actinal surface of the embryo starfish at the time it has just resorbed the pluteus, while the anal opening is still placed on the side of the actinostome. The actinal surface is identical in Starfishes and Ophurians, so far as the ambulacral system is concerned; while in Holothurians the actinal surface is analogous to the actinal side of Clypeastroids when the actinostome is eccentric posteriorly, and in which, supposing the mouth were marginal, we should have an actinal surface formed of the trivium, and not of the bivium, as in Spatangoids. It

seems, therefore, hardly justifiable, in comparing Holothurians and Spatangoids, to suppose the latter turned 360° round a vertical axis before we can compare them homologically; the difference in the constitution of the actinal surface depends entirely upon the position of the actinostome, which may be more or less anterior in Spatangina, or more or less posterior in Clypeastroids, or central in the Desmosticha, while it is marginal, or rather terminal, in Holothurians. In this connection we should remember that in the young of many Holothurians the actinal surface is formed, as in Desmosticha, of an equal portion of all the ambulacra, since their young creep upon their actinal gill tentacles, up to the time the ambulacral tentacles proper are developed.

The ambulacral system, the genital organs, the jaws, as well as the plates of the test, are arranged radially round a vertical axis; but even in these systems the plan of radiation is somewhat modified by a tendency to a bilateral symmetry in some of the groups. The alimentary canal has not a radial arrangement in any of the Echinoderms. The position of the anal system in the Clypeastroids and in the Petalosticha gives us two poles of an axis, which has been taken as the anterior axis in Spatangoids and in Clypeastroids, and on both sides of which there is a marked tendency to a bilateral arrangement in the ambulacral system. This axis becomes a vertical axis in the Desmosticha.

The atrophy of the genital organs in Petalosticha, by leaving either four, three, or even only two genital glands, tends to produce a bilateral arrangement in the genital organs, just as the specialization of the odd anterior ambulacral brought out more strikingly the bilateral tendencies of the petaloid ambulacra in the Petalosticha. But in spite of this tendency to a bilateral arrangement in the ambulacral and genital systems of the higher Echini, we cannot fail to be struck with the fact that the ambulacral system which the Echinoderms have in common with the Acalephs and Polyps is arranged according to the plan of radiation fully as clearly as in the other great classes of this branch of the animal kingdom. It cannot be denied that there are many excellent reasons for a closer association of the Acalephs and Polyps than either of them and the Echinoderms, yet until we can show that the radial ambulacral system of Echinoderms is not clearly homologous to the radial ambulacral system of the Acalephs and Polyps, we must retain these three classes in the same great branch of the animal kingdom.

There is a time, in the growth of all the Echinoderm embryos I have examined, when, after the resorption of the pluteus, there is no difference in the general structure of the young Ophiuran, Starfish, or Sea-Urchin. This stage is represented by a condition in which there are neither ambulacral nor interambulacral plates developed,—when the ambulacral system exists on the actinal side as a simple tube from which the more or less rudimentary suckers diverge as simple diverticula; in this stage the young Echinoderm is composed only of an actinal and of an abactinal side. The limestone network, covering completely the whole of the abactinal surface, is not yet subdivided into plates, neither genital nor ocular plates are developed, and only such coronal plates exist in Starfishes and Ophiurans as correspond to the centre of the disk and to the base of the arms. The spines, as well as the more or less indented outline, guide us in forming an idea of the order to which the young embryo is to belong. The anal opening is an aperture which in sea-urchins early reaches its ultimate position. The teeth of Echini also early appear, totally disconnected from the test. In the earlier stages of growth, even after the suckers have become encased in the limestone network of the actinal surface, the plates which are to form the ambulacral and interambulacral plates are not differentiated, and are only formed subsequently from what remains always (in Starfishes and Ophiurans) the abactinal part of the body, but which in Echini forms the so-called coronal plates, —modifications only of the primitive abactinal system of starfishes, as far as the plates immediately adjoining the ambulacral tubes are concerned.

This introduces some changes into the generally received homologies of Echinoderms, and gives us, perhaps more satisfactorily than any other explanation, the homologies of Ophiurans, which, having no interambulacral system, have remained, more than the starfishes, in the condition most closely approaching that of the typical Echinoderm embryo after its resorption of the pluteus; that is, the plates formed along the arms are not differentiated into the systems recognized in Starfishes and Echini, and remain always a part of the original primitive abactinal system, subsequently to the pluteus stage. We may also explain more satisfactorily the homologies of Holothurians, which would thus, in such forms as Synapta, where the ambulacral suckers are limited to those immediately round the actinostome, remind us of the most embryonic conditions which we find in Echini, Starfishes, and Ophiurans. The primitive abactinal system becomes greatly elongated, the ambulacral tubes extend with it to the other extremity, and no special ambulacral or

interambulacral plates are developed, as in Echini and Starfishes. Of course it is immaterial if there are subsequently ambulacral suckers piercing through the actinal system, as is the case in young Cuviera; the homology remains the same. If the general homologies of Echinoderms as thus sketched out are correct, we should reverse the position usually assigned to Holothurians, and place them lowest in the scale of Echinoderms, in spite of their apparent similarity to Worms, which has undoubtedly been the main reason for placing them at the head of the Echinoderms, to which position we would remove the Echini. The position of the Crinoids I should assume to be intermediate between the Holothurians and the Starfishes or Ophiurans. The position of the Holothurians is indeed very striking. They are undoubtedly most closely related to the Echini, yet in one case (Echini) the specialization of the Echinoderm is carried to its maximum degree, as far as the test is concerned; while in the other (Holothurians) they retain the internal structure of Echini, and yet recall the typical embryonic condition of Echinoderms after leaving the pluteus. Lovén has advanced a very similar view of the homologies of Echinoderms, and he has disconnected, as has been done in this chapter, the so-called coronal plates (test) from the ambulacral and alimentary systems. This has led him to some very ingenious homologies, which we are hardly able to follow in his *résumé* without the further additional details promised for a future memoir.

The key to the true homology of the Echini and Starfishes is given by the ocular plate of the Echini, first seen by Agassiz, in which the homologue of the odd terminal tentacle of the starfish, with its ocular speck (Ehrenberg), is situated. I have shown, in my Embryology of the Starfish, that the new ambulacral suckers and ambulacral plates are added in Echini and Starfishes between the pointed terminal sucker and the last-formed pair; new pairs of plates and suckers are always formed at the base of the odd terminal tentacle. The attempt which has been made to homologize the marginal plates of Starfishes in such genera as Astropecten, Astrogonium, Asteriscus, and the like, with the second and third set of interambulacral plates of Palaechinus, Archeocidaris, and Perischodomus, is more in accordance with the views of the homologies we have advanced; though this view can scarcely be considered tenable on the supposition that all the plates of the Perischoechinidae are homologous, and that the marginal plates of the Starfish genera just mentioned belong entirely to the abactinal system, and have nothing to do homologically with the interambulacral region.

We must also be cautious, in tracing the homologies between the ambulacral plates of Starfishes and Echini, to remember that the homology extends only to the passage of the ambulacral suckers, and that the position of the ambulacral tube is totally different in the two suborders, as has already been insisted upon by Müller; the ambulacral tube being placed behind the plates (in the interior of the test) in Echini, while in starfishes the ambulacral tube is situated between these plates in a channel formed by their sides. We can only homologize the auricles of the Echini to the continuation of the ambulacral plates of Starfishes in those genera in which the auricles are formed by the prolongation of the ambulacral, and not of the interambulacral processes. As far as the jaws of Echini are concerned, they do not belong, as I have already shown, to the test, they are not a part of the auricles, and hence are in no way to be compared to the actinal parts which have received the name of teeth in Starfishes and Ophiurans, and which probably correspond to the auricular processes.

I have nothing to add regarding the plan of development of Echinoderms in the different suborders. In addition to the memoirs of Müller but little has been added to our knowledge of the history of the order since the publication of my Embryology of the Starfish, beyond a Memoir of Metschnikoff. In this he has taken much the same view of the development of the Echinoderms which I first advocated in opposition to the views of Müller. The development of the Echinoderm, as I have shown, takes place in all the suborders upon the so-called water-system of the pluteus, — the pluteus, eminently bilateral, showing no trace whatever of the radiate structure, — and it is only when the Echinoderm has grown to lead an independent life that the radiate structure so characteristic of the adult is developed. The water-system is the only organ in the pluteus showing any approach to a radiating disposition; but this, after all, is really only a fan-shaped arrangement, for the rudimentary Echinoderm, till the last moments of the existence of the pluteus, can only be said to exist developed (like a surface in geometry) on the surface of the water system, while all the organs of the pluteus, the arms, the vibratile cord, the epaulettes, the calcareous rods, or wheels, and other limestone deposits, are perfectly symmetrical, placed on both sides of the longitudinal axis, which also divides the digestive cavity and œsophagus into equal halves.

As far as the affinities of the different suborders are concerned, we obtain remarkable results if we consider the pluteus alone. Some of the Holothu-

rians and some of the Starfishes (Cuvieria and Cribrella) have an analogous mode of development. The Auricularians (Synapta) are most closely allied, as far as the pluteus is concerned, to the Bipinnaria, and Brachiolaria (Asteracanthion). The pluteus of the Ophiurans is, on the contrary, most closely allied to that of Echinoids, while, as far as the Comatulae are concerned, they recall in their general features some of the Holothurian embryos.

As far as the affinities of the Echinoderms with Worms are concerned, the recent observations on Comatula, made by Metschnikoff, appear to strengthen the views of Huxley* and Haeckel, which are, however, entirely based on theoretical considerations.† The discovery of the final development of Tornaria, which till lately was supposed to be a starfish pluteus, has shown conclusively that the whole plan of its development is entirely different from that of Echinoderms. Although we have a water-system in Tornaria, it is not bilateral, but is dorsal, and the presence of a true heart shows that it has nothing in common with the water-system of Echinoderms; the transformation into the Balanoglossus takes place by a simple change of topography in the organs of Tornaria, while in Echinoderms we have a gradual resorption into the young Echinoderm of the whole of the Brachiolaria in Starfishes, of the Auricularia in Synapta, and of the pluteus in Echinoids and Ophiurans, though the development of the Echinus and Ophiuran does not seem to depend entirely upon this resorption, which does not always take place completely and is frequently accompanied by a greater or less previous decomposition of the arms.

As far as the early embryonic stages of the Echinoderms, Acalephs, and Polyps are concerned, the formation of the digestive cavity by the turning in of the outer wall of the embryo is the same in all, and in Ctenophorae the digestive cavity has walls fully as thick in the planula stage as those we

* For a discussion of these views, see my paper on Tornaria, Mem. Am. Acad., 1873.

† Of course it must be remembered, in making this comparison, that the Annulata are by no means a homogeneous group. The true Annelids are undoubtedly most closely related to the Crustacea and Insects, while the Gephyreans, Planarians, Nemerteans, and perhaps other Annulata, are more nearly allied to the Echinoderms, both from the nature of their embryological development and from the presence of a more or less complicated water-system, analogous to that of Radiates.

Systematists are evidently drifting back to some of the exploded (?) views, formerly held by Cuvier and till comparatively lately by Forbes, of the relationship of the Gephyreans with the Echinoderms. It may be, therefore, that the splitting up of the Annulata into two branches, the one (the Annelids proper and their allies) closely allied to the Arthropods, the other (the Gephyreans, Nemerteans, and the like) more closely related to the Echinoderms, may explain many doubtful points regarding the affinities of the Annulata as usually understood.

find in the corresponding stages of Echinoderms. The mode of formation of the ambulacral tubes in Ctenophorae is identical with that of the water-system of Echinoderms; they are formed as diverticula from the digestive cavity exactly as the water-system of Echinoderms is formed as a diverticulum from the digestive cavity. As I propose to return to this subject in a detailed Embryology of our common Ctenophorae, I only allude to this important structural affinity to maintain the views I still hold of the close relationship of the Ctenophorae and other Acalephs and Polyps with the Echinoderms.

It seems scarcely necessary to criticise the views lately thrown out by Haeckel of the composite nature of Echinoderms, in which he goes so far as to suggest the possibility of each arm of a Starfish and Ophiuran being an individual. This view is so contrary to all our ideas of the homologies of these animals with Sea-Urchins and Holothurians, that, unsupported as it is by any data, and simply thrown out as a theoretical hint, it need not detain us any longer. The hypothetical genealogical tree made by Haeckel of the derivation of Echinoderms is entirely at variance with what we know of the embryology and of the geological succession of the class, and no positive proof can as yet be given of any other affinity between Worms and Echinoderms than the superficial resemblance of some embryos of Worms and Echinoderms. In his genealogical tree of the Echini, Haeckel has been compelled to derive from the Cassidulidae, the Clypeastroids, as well as the Spatangoids, which culminate in the present period in two equivalent groups. This we can explain in no other way except that the Clypeastroids were a retrogressive group, and yet the variety of the forms under which they appear during the Tertiary period shows anything rather than the dying out of the suborder. He leaves entirely unexplained (not even questioned) the sudden passage from Echinocidaridae to Dysasteridae and to Galeritidae. We might understand, as stated before, the passage of the Echinocidaridae to the Galeritidae and to the Clypeastridae both from anatomical and embryological data, but such an anomaly as the transition or genetic connection of the Echinocidaridae with the Dysasteridae and Cassidulidae, and hence with Spatangoids, is the merest hypothesis, entirely unsupported either by anatomical or embryological data.

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